MASTER'S THESIS

Green ICT Maturity Model for Insurance

Measuring the maturity of Green ICT in the insurance sector

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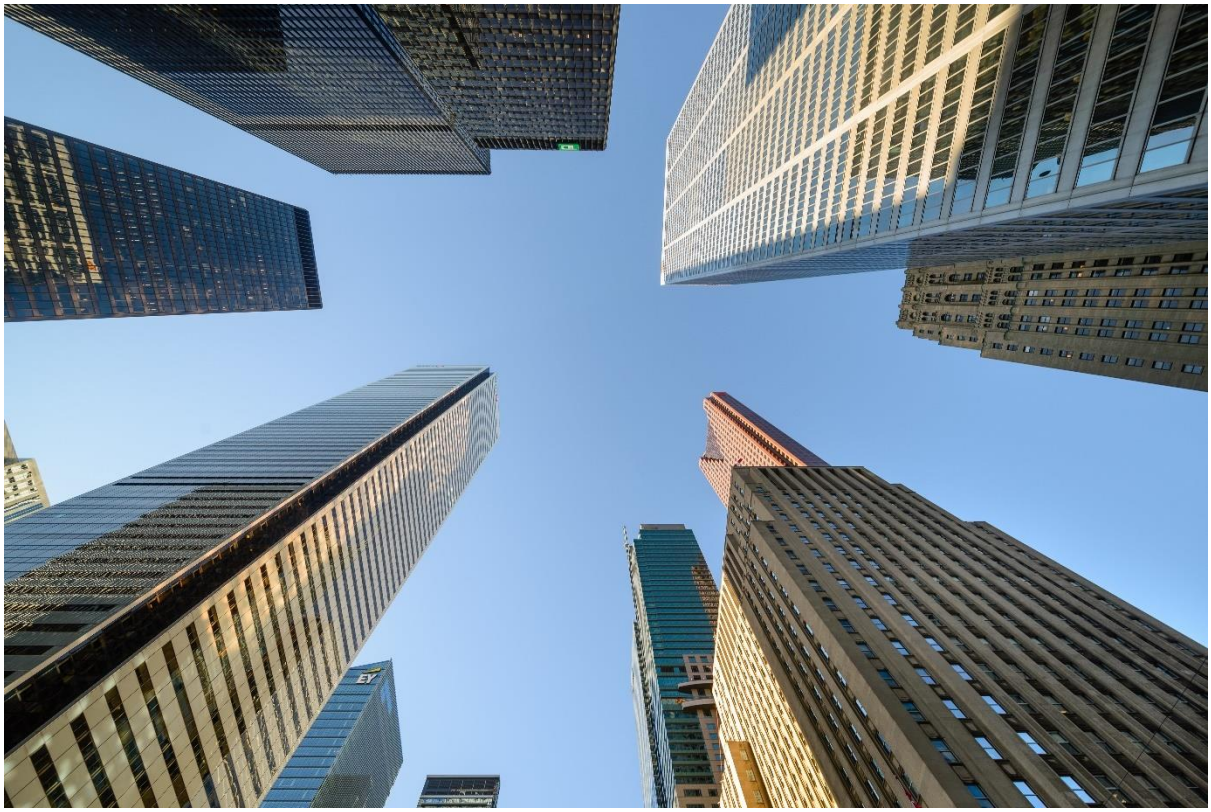

Image: Toronto Financial District. Source: Wikipedia

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Measuring the maturity of Green ICT in the insurance sector

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Abstract

Through literature research and expert knowledge, a Green ICT Maturity Model for the insurance sector was developed. It has six domains: Green Governance, Strategy, Policy and HR; Green ICT in the organisation; Greening of ICT; Greening by ICT; Greening of Primary Insurance Processes; and e-Waste Management. This model is a variation of the Hankel's SURF Green ICT Maturity Model. The Green ICT Maturity Model for insurance was validated by six respondents from five Canadian insurance companies. The Green ICT maturity levels were measured by the respondents who scored the maturity of the attributes within the domains. During interviews, respondents discussed questions on validity and usability of the maturity model. The interview results and respondent's insights led to minor changes to the model and measurement tool. Respondents agreed the model and measurement tool are complete, current, relevant, and user-friendly, and suitable for use in the insurance sector. Conclusions from the research results include the insurance sector in Canada has low Green ICT maturity and some Green awareness. They can improve green maturity, with executive buy-in, through policy and ICT initiatives to reduce the carbon footprint of the organisation. Recommendations for practice and future research completed this thesis.

Key terms

Green ICT, Green IT, Green IS, Maturity, Model, Measurement, Insurance

Summary

Information and Communication Technologies (ICT) affect the environment and climate change. The Global e-Sustainability Initiative report states that ICT is responsible for 2.3% of global carbon footprint, while ICT solutions could reduce the carbon footprint by up to 16%. Green ICT is defined as a combination of activities to minimise the negative impact of ICT on the environment and to increase the positive impact from using ICT to optimise business processes.

Insurance companies are ICT-intensive organisations. Applying Green ICT in the insurance sector should have direct and indirect positive impacts on the environment. Insurance companies do not have a scientifically relevant model to measure this impact. A validated Green ICT maturity model and measurement tool will enable a company to (self-)assess its Greening of and through ICT, monitor its progress over time, and become more competitive and socially responsible by reducing their environmental footprint.

Researchers have developed several Green ICT maturity models. Through literature research, nine Green ICT maturity models were selected and analysed. One model emerged as a good basis for the insurance sector: the SURF Green ICT Maturity Model. The model has four domains: Green ICT in the organisation (Domain 1), Greening of ICT (Domain 2), Greening of Operations with ICT (Domain 3) and Greening of primary processes with ICT (Domain 4). This model has a maturity measurement tool and is not specific to the insurance industry.

To make the SURF model more suitable for the insurance industry, the primary processes of the insurance value chain (Marketing, Product Development, Sales, Underwriting, Contract Management and Customer Service, Claim Management, and Risk and Asset Management) were added as attributes to SURF's Domain 4. With the SURF Green ICT Maturity Model's Domains 1, 2, and 3, and the following attributes, the Green ICT maturity model for the insurance sector, further referred to as GIMMi, was developed:

- attributes for people and culture, corporate social responsibility, green energy sources, green data centres, green standards and metrics and greenhouse gas emissions management
- Green Readiness model attributes: attitude, policy, practice, technology and governance
- a radiation emissions attribute
- e-waste attributes
- 1st , 2nd and 3rd Environmental Effects of ICT aligned with the above attributes, and
- ICT life cycle aligned with the above attributes.

Empirical research, with a multi-case study and six respondents from five insurance companies in the Canadian insurance sector validated the GIMMi. Six employees at strategic and tactical level, with different expertise from ICT and business areas, were interviewed using semi-structured interviews. A maturity measurement tool to measure the maturity level of the organisation was completed by each respondent before the interview. The model was discussed during the interview and specific questions were asked regarding correctness and completeness of the model. The respondents confirmed the GIMMi and measurement tool are relevant and easy to use. The measurement tool and results were discussed. Specific feedback was incorporated into the final version of the GIMMi model and measurement tool.

The goal of this thesis was to select, adapt, and validate a *Green ICT maturity framework that can measure, evaluate, and improve the environmental impacts of ICT in the insurance sector*. The respondents indicated that the model and measurement tool are suitable for the insurance sector.

From the maturity measurements it can be derived that the insurance sector can start using this model and measurement tool to assess Green ICT maturity. There is low awareness of the domains and attributes for Green ICT maturity. Maturity is low across all domains.

From the interviews it can be derived that executive buy-in is required. Clear policies and strategies need to be developed. Insurance companies need to have a purpose and intent to make a difference to reduce the insurance sector's carbon footprint. Green ICT assessment and improvement need to be incorporated into project and systems methodologies as Green ICT maturity is not a business priority. Executives often do not see the value and benefits of Green ICT as they do not see how it will help them make money and save costs.

Further research is required for validation, completeness and relevance involving domain experts, with more experts from the five respondents' organisations and with new organisations, with insurance companies that have achieved lower and higher levels of maturity in one or more of the domains. More feedback will help fine-tune the model and tool. Further research is also required for a web-based measurement tool. Research is required to develop a more detailed measurement tool for all domains, at the sub-attribute level. Research can be done on the differences between Property and Casualty (P&C) and Life insurance companies, based on assessed maturity, in domains and attributes, results and actions that can be taken. Further research can determine which results summaries are most effective in presenting the results of measurements (by year, year-over-year, and compared to other organisations and an industry average). Finally, more research is required on which maturity levels, by domain and attribute, provide different types of insights for the organisation and which types of specific actions are recommended to improve the maturity levels of domains, attributes and (ICT and business) processes.

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1. Introduction

1.1. Background

The United Nations' High-level Panel on Threats, Challenges and Change cautioned that environmental degradation is one of ten global threats. Environmental degradation is the deterioration of the environment through depletion of resources such as air, water, scarce resources and soil, the destruction of ecosystems and habitat destruction, the extinction of wildlife and pollution.

Sustainable refers to activities that allow a specific problem to be solved without having adverse implications in the future (Usman, 2017). Sustainable development is defined as development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs.' (Brundtland Commission, 1988). Green refers to the activities that provide a more efficient use of resources and minimise the harmful impact on the environment when compared to similar products. The triple bottom line theory expands the traditional accounting framework to include two other performance areas: the social and environmental impacts of their company. These three bottom lines are often referred to as the three P's: people, planet, and profit (Slaper, 2011). Van Marrewijk defines Corporate Social Responsibility as 'Companies with a CSR strategy integrate social and environmental concerns in their business operations and in their interactions with their stakeholders and demonstrate openly their triple P performances' (Dahlsrud, 2008). Carbon footprint is defined as a measure of the total amount of carbon dioxide (CO_2) and methane (CH_4) emissions of a defined population, system or activity (Wright, Kemp, & Williams, 2011).

The equation 'I=PAT' indicates that the environmental impact or degradation (I) is caused by the combination of a very large and increasing human population (P), continually increasing economic growth or per capita affluence (A), and the application of resource-depleting and polluting technology (T) (Global Policy Forum, 2003).

As part of this polluting technology, Information and Communication Technologies (ICT) have evolved into an integral part of current society and a driver of enhanced living conditions and opportunities around the globe. Growing Enterprise and ICT energy consumption is increasing CO_2 emissions. ICT causes environmental problems at each stage of its lifecycle:

- Raw material production: depletion of (scarce) resources; use of energy; impact on natural environment and air; climate change due to global warming, water, and animal habitat
- Manufacturing: use and depletion of (scarce) resources; use of energy; impact on natural environment; emissions (CO_2, radiation); waste (reuse, recycle, dispose as garbage)
- Use and maintenance: use of energy; climate change due to global warming, water, and animal habitat; emissions (CO_2, radiation); waste
- Disposal: waste (reuse, recycle, dispose as garbage).

ICT can also be used to improve areas such as carbon footprint calculation, deployment of computerised models for increasing energy efficiency and reduction of greenhouse gas emissions (Buchalcevova, 2015). Green ICT is a combination of activities which can minimise the negative impact of ICT on the environment and increase the positive impact from using ICT to optimise business processes (Hankel, Heimeriks, & Lago, 2017). ICT's carbon footprint is expected to decrease to 1.97% of global CO_{2e} emissions by 2030, compared to 2.3% in 2020. ICT can enable a 20% reduction of global CO_{2e} emissions by 2030, holding emissions at 2015 levels (Global e-Sustainability Initiative, 2015). By deploying more ICT, the insurance sector will increase ICT energy consumption

and costs, pollution, CO_2 emissions, resource depletion and environmental impacts. It can reduce its overall environmental impact and energy consumption through ICT.

1.2. Exploration of the Topic

In 2015, 195 of the UN member nations signed The Paris Agreement to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2^{o}C above pre-industrial levels. The Agreement aims to strengthen the ability of countries to deal with the impacts of climate change and to enhance transparency for action. To reach ambitious goals, appropriate financial funding and a new technology framework are required. The framework will fully realise technology development and transfer and improve resilience to climate change and reduce greenhouse gas emissions. As a result, an enhanced capacity building framework will be put in place (United Nations Climate Change, 2015). Increased CO_2 emissions caused by energy production and consumption increase temperature due to the enhanced greenhouse effect. As a consumer of energy and enabler of the new technology framework, ICT across the globe have a key role to play in dealing with the climate change impacts.

The widespread use of wireless technologies has increased public exposure to broader and higher frequencies of the electromagnetic spectrum to transmit data through a variety of devices and infrastructure. Radiofrequency radiation (RF) increasingly is becoming a new form of environmental pollution. The expansion of broadband with shorter wavelength radiofrequency radiation highlights the concern that health and safety issues remain unknown. Controversy continues from harm due to current 2G, 3G and 4G wireless technologies. 5G technologies are far less studied for human or environmental effects (Russell, 2018).

Maturity models represent theories about how organisational capabilities evolve in a staged manner along an anticipated, desired, or logical maturation path. A Design Principles framework represents a pragmatic, well-founded 'checklist' to enable comparison of maturity models and to disclose in what respect a specific maturity model requires further substantiation (Pöppelbuß & Röglinger, 2011).

Green ICT Maturity Models (GITMM) vary in abstraction level, scope, and ease of use. They share a similar structure, a general idea of what should be included, a two-tier system (categories in which components are grouped together), and extra aspects such as maturity levels to direct improvement. This general structure indicates a future standard structure for assessing, evaluating, and improving the use of Green ICT. If many organisations use the same model or at least the same structure in their models, this could pave the way for standardisation and eventually benchmarking (Hankel et al., 2017).

Peter Drucker said, 'If you can't measure it, you can't manage it.' Green ICT performance is no exception – a standard scientific measurement framework for Green ICT is not available for many sectors. An organisation must first assess the current state of its Green ICT performance before it can carry out actions to improve (Park, Eo, & Lee, 2012). Research has been done on how maturity models can help measure the level of Green ICT in a structured manner (Hankel et al., 2017; Molla & Cooper, 2010; Pöppelbuß & Röglinger, 2011). The Green ICT maturity levels can help assess the current organisation's green capability and/or readiness and/or maturity, to compare measurements over time and to benchmark measures to other organisations.

For an organisation to mature its Green ICT, it must have the capabilities, attitude, and capacity to mature. Green readiness is an organisation's capability in greening ICT to reduce ICT, business process and supply chain related CO_2 emissions; reduce waste and water use; improve energy efficiency; and generate green economic rent. Green-readiness can demonstrate the comparative levels of green development among businesses and is a measurement of the Green ICT capabilities of an organisation (Molla, Cooper, & Pittayachawan, 2011).

1.3. Motivation and Relevance

Social relevance

International initiatives like the Paris Agreement strengthen the ability of countries and institutions to deal with, cooperate on, and train stakeholders on the impacts of climate change and to enhance (transparency for) action including the use of ICT in these initiatives (United Nations Climate Change, 2015).

Scientific relevance

Despite concerns for the environment and having Corporate Social Responsibility policy statements, few organisations consider green issues. This demonstrates a disconnect between policy and practice, and variations in the actions and practices of Green ICT (Molla & Cooper, 2010). Green ICT supports organisations in achieving their social responsibility and sustainability goals. In order to do so, they need to know how ICT can affect their environmental footprint in both negative and positive ways (Hankel et al., 2017).

During the last 15 years, the topics 'Green ICT', 'Green IS', 'Green IT' and 'maturity models' have been researched. Measurements, insights, and models have been developed and compared resulting in better models and insights. Recommendations for additional research into enhancing the models is ongoing. Most models are applicable in general or apply only to specific industry sectors. Green ICT research specific to insurance is currently limited and researching a model and insights for insurance would benefit the improvement of Green ICT maturity for the insurance sector.

Relevance to the insurance sector

Insurance companies and individuals have multiple interactions with multiple organisations in the insurance value chain every year. These hundreds of millions of interactions, mostly supported and enabled by ICT, and the increase of digitisation over the next 10 years, have had negative and positive impacts on the environmental footprint of insurers. The insurance sector would benefit from a structured and comprehensive measuring and comparing of Green ICT maturity, obtaining sustainability insights, and enabling the improvement of its environmental footprint over time.

1.4. Problem Statement

Corporate Social Responsibility (CSR) is a trending topic and is top of mind for many executives. Drucker proclaimed that fulfilling social responsibility is not only a duty but could result in competitive advantage (Cohen, 2009). An organisation's capability to comply with the mounting demands of different environmental groups and government regulations and to practice socially oriented moral management is a major concern and an issue that might affect competitiveness (Molla et al., 2011).

More and more, insurance companies need to be (more) competitive and socially responsible. One of CSR's focus is the environment, so they can focus on reducing their environmental footprint. The use of ICT has direct negative and positive impacts on this footprint.

These impacts have not been measurable (over time). The insurance sector does not have a standardised and scientifically relevant framework or model to measure Green ICT maturity. A framework will help measure the impact of ICT on the environment, help reduce ICT's own environmental footprint and provide solutions to positively impact the footprint. Since insurance sector measurements are not available, clear, and comprehensive insights into Green ICT maturity and ICT's environmental footprint have not been available. There is also a lack of specific actions for improvement over time.

In summary, the problem statement is: *Insurance companies have not been able to systematically improve their environmental footprint due to the lack of a standardised and comprehensive framework to measure Green ICT maturity and action insights from these measurements.*

1.5. Research Objective and Questions

The research will seek out, develop, and/or enhance a relevant Green ICT Maturity Model (GITMM) for the insurance sector to measure and assess the positive and negative effects of ICT on the environment. The research will also provide recommendations to improve the effects of ICT, as to achieve sustainability goals and improve Green ICT maturity over time. The literature reviews will build on relevant Green ICT Maturity Models, previously researched by other Open Universiteit Master of Science BPMIT students. This previous research will be used as a base for this research. One of their findings was that a model should be suitable for a range of organisations and include generic domains such as 'Green ICT in the organisation', 'Greening of IT', 'Greening of operations with ICT' and a sector specific domain 'Greening of primary processes with ICT' (Hankel et al., 2017).

The Research Question is: *Which Green ICT maturity framework can measure, evaluate, and improve the environmental impacts of ICT in the insurance sector?*

Preliminary, literature and empirical research expands this research question, as shown in Table 1.

1.6. Main Lines of Approach

In section 2, preliminary research provides an overview of the use of ICT in the value chain in the insurance sector including key business processes of sales, underwriting, contract management and claim management. Section 3 outlines the literature research approach and defines the theoretical framework and criteria for (Green ICT) maturity models and how to define a relevant Green ICT maturity models for the insurance sector. As a result, a Green ICT maturity model for the insurance sector is defined. In section 4, empirical research validates the Green ICT maturity model for the insurance sector through a case study in one insurance organisations. The conceptual and technical design of the research describes the how and why, and the appropriateness, of these designs. It also describes how to analyse and substantiate the collected data. Finally, arguments demonstrate why the empirical research is set up in a sound, prudent manner and why the results are valid. Section 5 describes how the research was executed and how it deviated from the design. The research results are summarised. Section 6 discusses the outcomes of the empirical research. It positions the research results in relation to the literature and provides insights and learnings from the research. Recommendations for practice and future research topics are provided. Finally, the researcher reflects on the validity and reliability of the empirical research.

Table 1. *Preliminary, Literature and Empirical Research Focus*

Area of research	Research focus	Topics to be researched
Preliminary research	P. What are the effects of ICT on insurance's primary processes? What are the relevant aspects of Green ICT in the insurance sector?	P1. What is insurance? P2. What are the primary business processes of insurance? P3. How is ICT used in these business processes? P4. What is the relevance of Green ICT in insurance?
Literature research	L. Which Green ICT Maturity Model is best to use in the insurance sector?	L1. What is Green ICT? L2. What is a maturity model? L3. What are the criteria for a Green ICT maturity model? L4. What are the criteria for a Green ICT maturity model for the insurance sector? L5. From literature, are there suitable Green ICT maturity models for the insurance sector? L6. Which Green ICT maturity model is suitable for the insurance sector?
Empirical research	E. Is the proposed Green ICT maturity model complete, relevant, and usable in the insurance sector, is it effective in measuring maturity for companies in the insurance sector, and what is the maturity of the case organisation?	E1. Is a Green ICT maturity model effective in measuring Green ICT maturity in the insurance sector? E2. Does the insurance Green ICT maturity model for insurance need to change to measure maturity? E3. Does the insurance Green ICT maturity model provide impacts and insights in (lack of) the maturity of the organisation? E4. Can the maturity model's results help define actions and improvements for Green ICT? E5. What is the maturity of the case organisation?

2. Preliminary Research on Insurance Sector

This section provides an overview of ICT for the insurance sector, the effects of ICT on primary processes and the relevance of Green ICT.

2.1. Research Approach and Execution

Table 2 shows the sub-questions, sources for the answers and how the research is executed. As the researcher of this thesis has been a CIO in the insurance field, he is a key source of knowledge.

Table 2. *Sources for Preliminary Research for insurance*

Preliminary research questions	Sources	Execution
P1. What is insurance?	Insurance literature	From Wikipedia, describe what insurance is
P2. What are the primary business processes in insurance?	Published article(s)	From literature, show the value chain for insurance sector
P3. How is ICT used in these business processes?	Published article(s). Researcher's experience in the insurance sector	From literature, identify and summarise use and provide examples. Refer to more details
P4. What is the relevance of Green ICT in insurance?	Published article(s). Researcher's experience in the insurance sector	Evaluate relevance

2.2. Research results

2.2.1. Definition of Insurance

Insurance is a practice by which an organisation provides a guarantee of compensation for a specified loss, damage, illness, or death in return for payment of a premium. Insurance involves pooling funds from many insured entities to pay for the losses that some may incur. The insured entities are protected from risk for a fee, with the fee being dependent upon the frequency and severity of the event occurring. The insurance industry has many types of insurance and is often divided into two insurance sub-sectors: P&C and Life insurance. P&C (Property and Casualty) insurance exists for personal and commercial purposes and includes home, building, auto, workers compensation and liability insurance. Life insurance can be obtained by individuals and groups. It includes life, injury, and health (dental, physiotherapy, prescription drugs, travel, etc.) and (critical) illness insurance ("Insurance," 2019).

Clients (referred to as insureds) are people or companies that buy the insurance. One or more insureds are named on an insurance policy. Service providers work as an intermediary between the insurance company and the insured to sell insurance, service insurance policies and provide claims services (doctor, auto body repair shop, counsellor, etc.). Employees of an insurance company market products, sell and underwrite policies, administer policies, provide customer service, and manage and adjust claims.

2.2.2. Insurance Business Processes

The insurance value chain in Figure 1 distinguishes the primary and supporting activities of an insurance company to deliver a product or service. Porter's value chain is adapted by Rahlfs using the insurance-specific value chain (Eling & Lehmann, 2018). The primary activities employ the most people and are ICT-intensive activities and are described in more detail in Appendix 1. The ICT of an insurance company encompasses all the IT equipment used by the employees and the IS systems and applications provided to employees, service providers and clients to manage policies and claims. ICT are utilised in all business processes of the insurance value chain by clients, service providers and

employees, through sales, claims and service portals, mobile apps, big data, and legacy systems. Examples include buying insurance through mobile apps, initiating a car accident claim by iPad and facilitating doctors' visits of injured people through mobile app-based software and/or video conferencing.

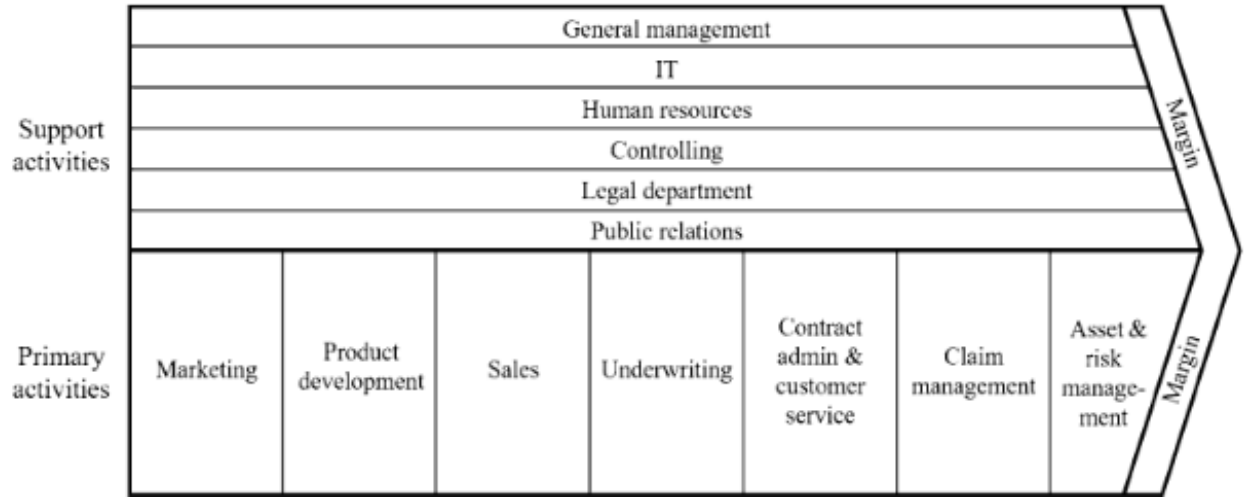


Figure 1. Value chain for the Insurance Sector (Eling & Lehmann, 2018)

2.2.3. Effects of ICT Use in Insurance

While digitisation has already substantially transformed many industries, the transformation in the insurance industry has yet to exploit the full potential of digital technologies (Eling & Lehmann, 2018). IT departments must find ways to manage the evolution of insurance companies' core systems while enabling rapid absorption of technological innovation. Technology innovations significantly impact the insurance sector:

- Client/channels: technologies are evolving, offering new and multi-channel options for client interaction (portals, smart phone, mobile, chatbots, social media, AI (artificial intelligence), IoT (internet of things))
- IoT/Big Data analytics: new ways of assessing and managing risk and claims (connected sensors, telematics, health sensors, robotic process automation and data from these and social media)
- Core systems: new digital solutions are challenging legacy systems (SaaS, software as a service) and other Cloud offerings and integrations with change in the core systems functionality for policy administration, claims management, and billing and payments and integrations of these with external parties
- Cloud computing: on-premise IT infrastructure modernisation with infrastructure as a service (IaaS) and other Cloud offerings and integrations.
- A combination of all of the above resulting in an even greater impact (Eling & Lehmann, 2018; Hocking et al., 2014).

This shows that the insurance sector is technology and data-intensive with extensive electronic communications between primary activities and external stakeholders such as regulators, service providers, clients, claimants, brokers, sales channel consolidators, financial and industry organisations. Many ICT projects in the insurance sector are under way with a focus on core system replacement, business transformation, digitisation, cost reduction, Big data, IoT and AI. Deployment of these projects will impact energy consumption, pollution, resource depletion and environmental impacts.

2.2.4. Relevant Aspects of Green ICT in Insurance

A systematic focus on Green ICT through maturity measurement would allow insurers to address the negative impact on the environmental footprint and find opportunities for ICT to make a positive impact. Insurance companies generally have a low awareness of all the aspects of Green ICT. To be successful with Green ICT, the insurance sector must have the intention and capability to improve and adopt effective Green ICT practices.

Molla et al. (2011) differentiate between the intention and the actual adoption of Green ICT. Adoption is driven by economic, regulatory, and ethical factors, and these apply to the insurance sector:

- Economic: find cost reductions in the use of IT, energy efficient IT equipment, or cost reductions through IT solutions to improve business processes and their environment footprint (i.e., telework, video conferencing)
- Regulatory: align with national and international sustainability regulations and
- Ethical: be influenced by customers and service providers to be 'green', i.e., customers who don't want paper bills, or who want to buy online (Hankel et al., 2017).

Even with the intention to adopt Green ICT, this does not mean they have the capability. Molla et al. (2011) identified five capability properties ('Green-readiness'): attitude, policy, practice, technology, and governance. From the researcher's experience over the past 20 years working with insurance companies in Canada, insurers have started to take actions, for example, by reducing paper use and travel for claims management, adopting policies for e-waste in all primary business processes, and implementing electronic sales and supply chain channels. However, many insurers are not Green-ready. They lack the attitude towards improving the environmental impact as cost reduction and profitability drive insurers. Due to a lack of policies, strategy, and Corporate Social responsibility, they lag in becoming more environmentally friendly. Knowledge about practices for Green ICT and technology is required to be effective in Green ICT. A lack of governance has hindered them from ensuring that Green ICT initiatives deliver on their business case.

Once the insurance sector is Green-Ready, the OECD's Green ICT framework can be used to outline the direct, enabling and systemic environmental impacts of ICT (Mickoleit, 2010)These impacts apply across the value chain of insurance companies:

- Direct: Procurement of (greener) technologies will reduce the total cost of ownership of computing, network, storage and end user equipment including reduced energy and materials use; reduced and recycled E-waste, energy and material use in the supply chain of insurance IT solutions
- Enabling: Streamlining the use of ICT so that employees, clients and sales agents sell insurance and manage claims more resource efficient and environmentally sound (i.e., use video conferencing solutions, smart phone apps for claims, embedded systems in cars for fuel-efficient and safer driving, intelligent heating and lighting systems in buildings). Reductions in travel, energy and paper use when selling and producing products, servicing customers, processing claims, and managing assets. Replacing physical products with digital products and processes such as teleconferences to replace business travel.
- Systemic: Make Green behaviour part of the corporate policy and strategy and integral to all business processes, including intended and unintended consequences of Green ICT applications. ICT can have systemic impacts by providing and disclosing information (e.g., smart meters and sensors that collect information to be used to adapt lifestyles, production, and commerce) to the impacts of climate change. It can also foster technology adoption (i.e., policy re: carbon neutral

business travel, electrifying the office for heating/ no use of fossil fuels for heating the office or corporate cars).

Table 3 describes the effects of the ICT use in an insurance company's primary process for sales, underwriting, contract admin, customer service and claims management.

Table 3. *Effects of ICT Use in Insurance Processes*

Effect	Source	Sales and Under writing	Contract admin and customer service	Claims mgmt	Description – where can IT help
Reduce energy use in data centres and communication networks	(Hankel et al., 2017)	x	x	x	Relevant to all internal and external electronic communications related to all transactions in the business processes
Reduce use of scarce materials in the production of ICT equipment	(Hankel et al., 2017)			x	Relevant as electronic devices are used extensively in business processes, multiple devices per person, and procurement practices of ICT equipment consider scarce materials use in the production of this equipment
Reduce e-waste	(Hankel et al., 2017)	x	x	x	Relevant as electronic devices are used extensively in the business processes, multiple devices per person
Reduce travel	(Hankel et al., 2017)	x	x	x	Relevant as travel is required for meetings and sales activities and extensively to manage claims
Reduce paper use	(Hankel et al., 2017)	x	x	x	Relevant as insurance transactions still use paper extensively, even though electronic document use has increased
Reduce materials use	(Hankel et al., 2017)			x	Relevant as (fire and damage) claims for cars, houses, businesses require the use of a variety of materials to fix the damage
Optimise business processes	(Hankel et al., 2017)	x	x	x	Relevant for the reduction of throughput times for sales, service, and claims transactions
Optimise technical and people infrastructure	(Molla et al., 2011)	x	x	x	Relevant for the realisation of the impact of ICT by ICT
Improve control of the ICT infrastructure	(Molla et al., 2011)	x	x	x	Relevant for the realisation of the impact of ICT by ICT

3. Theoretical Framework

This chapter describes the literature research for a Green ICT maturity model for the insurance sector and comprises of the literature research approach, implementation of literature search and the search results and conclusions. The answers to the six literature research questions (chapter 1.5) form the theoretical framework and a scientific foundation for the definitions of Green ICT and terminology related to maturity models.

3.1. Research Approach

The research plans to develop a Green ICT Maturity Model (GIMM) for use in the insurance sector. The key question is: *Which Green ICT maturity framework can measure, evaluate, and improve the environmental impacts of ICT in the insurance sector?*

Appendix 2 shows a list of 24 articles and thesis reports on 'Green ICT and maturity models' provided by Dr. Anda Counotte and provides a starting point for literature research. The thesis reports are from past students from the Open University Netherlands' Master's Degree in Business Process Management and IT program who completed research on selecting Green ICT maturity models for various industry sectors.

Table 4 provides the literature research questions, the purpose of each question, the search method, and the approach(es) for research of each question.

Table 4. *Purpose and Approach for Literature Research Questions*

Literature research question	Purpose of question	Search Method	Approach and sources
L1. What is Green ICT?	The research will look for definitions of Green ICT from various authors, compare them and provide the most recent findings.	Forward Snowball	Review of published articles, provided as core literature, and literature found by past MBPIT students.
L2. What is a maturity model?	The research will look for definitions of maturity models from various authors, highlight differences and similarities, and provide a context for how to use maturity models in the empirical research	Forward Snowball	Review of published articles, provided as core literature, and literature found by past MBPIT students.
L3. What are the criteria for a Green ICT maturity model?	The research will assess the criteria of Green ICT maturity models to be used in scientific research and indicate which ones are to be used for empirical research	Forward Snowball Building Blocks	Review of published articles, provided as core literature, and literature found by past MBPIT students.
L4. What are the criteria for a Green ICT maturity model for the insurance sector?	The research will assess the criteria of Green ICT maturity models to be used in scientific research and indicate which ones are to be used for empirical research in the insurance sector	Building Blocks	Review of published articles found through library research.
L5. From the literature, are there suitable Green ICT maturity models for the insurance sector?	Using the criteria from L4, the research will look for suitable Green ICT models to be used in the insurance sector	Building Blocks	Review of published articles found through library research.
L6. Which Green ICT maturity model is suitable for the insurance sector?	Using the results from L4 and L5, the research will look for a suitable Green ICT maturity model that will be used for the empirical research	Building Blocks	Review of published articles found through library research.

Research Questions L1-L3 will use the forward snowball method. Snowballing searches use the starting list of articles (Appendix 2) and search for additional and new articles on the topic areas Green IT, maturity models and Green ICT maturity models. Snowballing searches for references in the articles, for articles the referenced article is cited in, for articles by the same the authors and for related articles in the journals the article was published in. Appendix 3 provides the details for the snowball research approach for L1-L3.

Research Questions L3-L6 will use the building blocks method which searches the literature by breaking the topic into different 'building blocks of search terms.' Appendix 4 provides the details for the building blocks approach for L3-L6. Five queries for L3 and eight queries for L4-L6 formed the basis for multiple iterations. Additional search criteria were used for these iterations including selecting specific databases and selection of time frames including last 5 years.

3.2. Implementation

3.2.1. Forward Snowballing research

Forward snowballing was completed for each of the articles provided as a starting list (Appendix 2), Backward snowballing research was not completed due to the limited time available to do the literature searches. Forward snowballing searches L1-L3 identified 4,535 citations related to Green ICT, maturity models and Green ICT maturity models. The searches resulted in three new articles (see Table 5 for summary and Appendix 3 for details). After scanning these three articles for relevance and usability, the articles were added to the list of 'Relevant articles from Literature Search Results' in Appendix 6.

Table 5. *Forward Snowballing Search Results*

Literature research questions	Reference articles used for snowballing	# of Citations	New articles
L1. What is Green ICT?	(Molla & Cooper, 2010)	94	
	(Counotte-Potman, 2010)	0	
	(Molla et al., 2011)	103	1
	(Sheridan, Ellis, Castro-Leon, & Fowler, 2012)	97	1
	(Lennerfors, Taro, Fors, & van Rooijen, 2015)	27	
	(Curley, Kenneally, & Carcary, 2016)	3	
	(Lennerfors et al., 2015)	13	
	(Patón-Romero, Baldassarre, Piattini, & de Guzmán, 2017)	16	
L2. What is a maturity model?	(Paulk & Curtis, 1993)	2748	
	(Becker, Knackstedt, & Pöppelbuß, 2009)	694	
	(Pöppelbuß & Röglinger, 2011)	255	
L3. What are the criteria for a Green ICT maturity model?	(Molla & Cooper, Vanessa Pittayachawan, 2009)	208	
	(Philipson, 2010)	34	
	(Donnellan, Sheridan, & Curry, 2011)	125	1
	(Park et al., 2012)	29	
	(Curry & Donnellan, 2012)	38	
	(Hankel, Oud, Saan, & Lago, 2014)	25	
	(Buchalcevova, 2015)	16	
	(Foogooa, Bokhoree, & Dookhitram, 2015)	2	
	(Hankel et al., 2017)	5	
	(Lautenschutz, España, Hankel, Overbeek, & Lago, 2018)	3	
Total			3

3.2.2. Building block research

The query searches L3-L6, defined in Appendix 4, were executed. Based on early search results from Google Scholar and the Open Universiteit Library, the searches were changed by refining and changing the query parameters. Each query search followed the following iterative steps:

- Run the queries and examine results to find relevant items
- Modify queries to improve your results.
- Revise and re-run strategy based on observations.
- Repeat this process until satisfied or further modifications produce no improvements.
- Keep detailed notes on the literature search, as it will need to be reported (Boren & Moxley, 2015).

The searches for the Building Block queries for Questions L3-L6 resulted in 28 articles found to be relevant (see Table 6 for a summary, Appendix 5 for details). Five queries for Questions L3 and eight queries for Questions L4-L6 formed the basis for multiple iterations. These queries resulted in over 460,000 search results/ hits in OU library and Google Scholar. With each result set, titles were scanned for potential suitability. Of these 460,000, over 1,800 articles were scanned by reviewing the title, author, date, number of citations, key terms, and abstracts. This scan resulted in 28 articles deemed to be relevant. Once a title was deemed relevant, the details for this article where placed in a table (Appendix 6), and the article and its citation were downloaded into the application Mendeley. If the article was available, the article was uploaded into the Mendeley application. With seven duplicates, 21 articles were selected with the potential of being used in this thesis. These 21 were added to the list of 'Relevant articles from Literature Search Results' in Appendix 6 – the last column indicates if the article was used or why not.

Table 6. *Building Block Search Results*

Literature Research Question	Query #	Hits in OU Library	Hits on Google Scholar	Number of Hits Scanned	Number of Articles Found Relevant
L3	1	108	16,400	94	6
	2	94	16,300	94	6
	3	10	129	139	2
	4	242	17,300	242	2
	5	43	243	243	2
L4, L5, L6	1	137	87,500	137	2
	2	30,266	246,000	50	1
	3	343	17,200	200	0
	4	137	22,400	137	2
	5	80	1,350	80	0
	6	0	1,500	155	4
	7	14	5,600	250	1
	8	9	1,170	9	0
				Duplicates	-7
Total		31,483	433,092	1,830	21

3.2.3. Summary of Search Results for Questions L1-L6

Twenty-four 'Relevant articles from Literature Search Results' (3 from Forward Snowballing and 21 from Building Block searches) were identified and are listed in Appendix 6. These articles were reviewed in detail. Seven were used to address Questions L3-L6 in section 3.3. After careful review, the other seventeen articles contained no relevant data to help address the literature research questions L1-L6 – reasons for not using are provided in Appendix 6 - last column.

3.3. Results and Conclusions

3.3.1. L1. What is Green ICT?

Information Technology (IT) refers to computer hardware, software, and peripheral equipment. Information Systems (IS) is a broad concept that covers the technology components and human activities related to the management and employment process of technology within the organisation. The term Green refers to technologies and processes that are environmentally friendly, i.e., which have a lower negative impact on the natural environment than conventional ones.

Loeser states that the analysis of prevalent literature illustrated that a clear definition and a coherent distinction between the concepts of Green IT and Green IS are required to provide clarity to academics and practitioners. Many definitions of Green ICT emphasise the distinction between Green IT and Green IS. The concept of Green IT refers to measures and initiatives which decrease the negative environmental impact of manufacturing, operations, and disposal of Information Technology (IT) equipment and infrastructure. Green IS refers to practices which determine the investment in, deployment, use and management of information systems (IS) in order to minimise the negative environmental impacts of IS, business operations and IS-enabled products and services (Loeser, 2013).

Figure 2 shows this: Green IT has 1st degree (direct) environmental impact, while Green IS has 1st, 2nd, and 3rd degree (direct, indirect and systemic) environmental impacts of ICT.

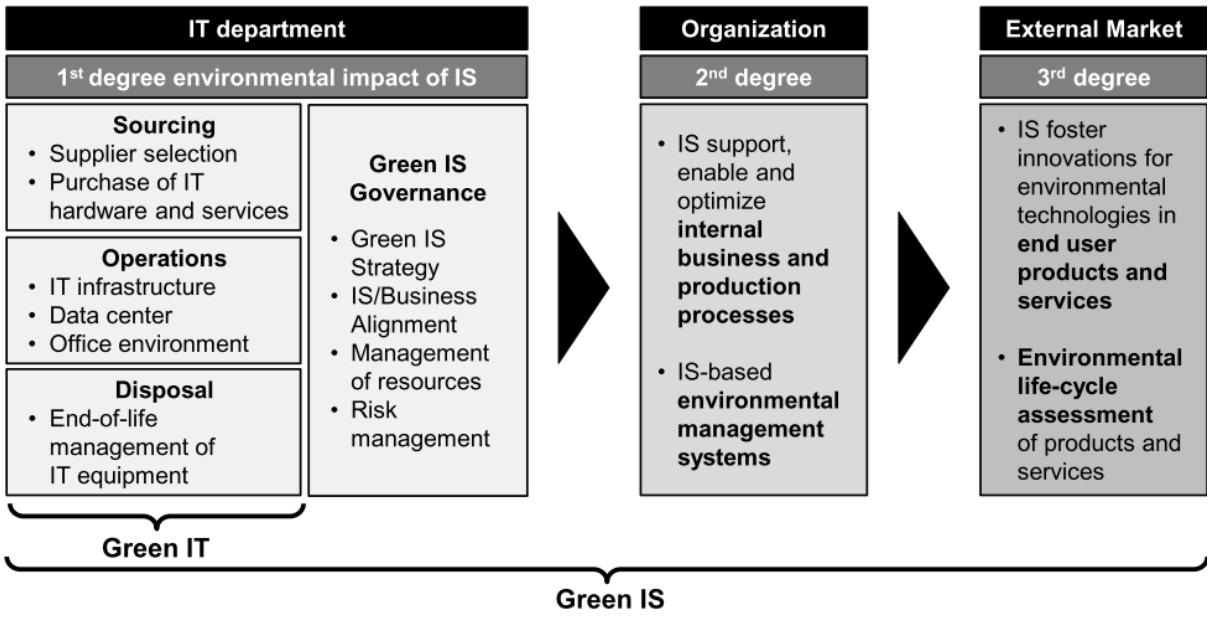


Figure 2. Environmental impact of Green IT and Green IS (Loeser, 2013)

Green IT includes elements such as The Triple Bottom Line (People, Profit and Planet), which balances the three dimensions of Sustainability: Social, Economic, and Environmental. The impact on the environment is considered when planning for profit and growth, which will lead to a more sustainable outcome (Joyce & Paquin, 2016). Direct, indirect and system impacts were introduced in section 2.2.4 where it was noted that insurance companies see these impacts across the value chain. Since the relations between ICT and the environment are numerous and often complex, it is important to be aware of the effects they have on each other as any change in one may have:

- A direct impact on the other, for example, resource consumption.
- An indirect impact that may optimise other processes; and/or

- A long-lasting systemic impact on people's behaviour, adoption and innovation, and thus the larger system of organisations, markets, and societies (Hankel, Heimeriks, & Lago, 2018).

Green ICT is an important set of activities affecting these impacts. Green IS strategies mediate the relationship between environmental orientation and the implementation of Green IT practices and Green IS practices, which in turn lead to organisational benefits in the form of cost reductions, corporate reputation enhancement, and Green innovation capabilities (Loeser, Recker, vom Brocke, & Molla, 2017).

Hankel et al. (2017) define Green ICT as: *The combination of activities to minimise the negative impact of ICT on the environment and to increase the positive impact from using ICT to optimise business processes, or any activity that considers the direct, indirect and systemic impact of ICT on the environment.* This definition of Green ICT will be used in this report as this is a succinct definition that covers the definitions from others.

3.3.2. L2. What is a maturity model?

The Capability Maturity Model (CMM) is the first maturity model, used to improve the software development process, necessary as a basis for the support of subsequent improvements. It has five maturity levels, 1 to 5: initial, repeatable, defined, managed and optimised levels (Paulk & Curtis, 1993).

The application of maturity models has benefits. Maturity models define simplified maturity stages or levels and measure the completeness of the analysed objects. Maturity models generate an awareness of the analysed aspects: their state, importance, potential, requirements, complexity, and so on. They may serve as a reference frame to implement a systematic and directed approach for improvements on a comparable basis. The progress in maturity is an evolution path for potential or desired improvements (Wendler, 2012).

Authors of new maturity models should validate maturity models to assure their suitability and relevance, especially when practical application is the stated research purpose. However, the question how to validate a maturity model appropriately is very difficult - no ''ideal'' validation method is available. A combination of multiple methods in different research states seems recommendable. Such course of action ensures to include empirical data at early research stages, for instance by conducting piloting workshops or interviews and therefore improve the suitability of the developed maturity model. Ongoing validation may take place while using the maturity models in real environments to test its applicability and search for improvements. Qualitative methods are important to gain a deep understanding of the object of research, but a combination with quantitative approaches has the potential to deliver generalised insights (Wendler, 2012).

For this thesis, a *maturity model is a conceptual model based on the idea that organisational capabilities develop through a sequence of anticipated, desired, or logical stages from an initial to a more mature state.* Maturity models are a common tool that organisations use to assess their maturity in a specific domain and guide their continuous improvement processes. The basic components of a maturity model are:

- Maturity levels. A maturity model consists of a sequence of maturity levels for a class of objects. It represents an anticipated, desired, or typical evolution path of these objects shaped as discrete stages. The initial state characterised by an organisation having limited capabilities. The highest stage represents a conception of total maturity. Advancing on the evolution path between the two extremes involves a continuous progression regarding the organisation's capabilities. The maturity model serves as the scale for the appraisal of the position on the

evolution path. It provides criteria and characteristics that need to be fulfilled to reach a particular maturity level (Becker et al., 2009).

- A set of dimensions, aspects, concepts, key process areas or functional areas ('attributes') that can be developed along a predefined evolutionary path to achieve the defined maturity levels, and
- Descriptions of each step on the path typically consisting of guidelines, key processes or best practices (Lautenschutz et al., 2018).

3.3.3. L3. What are the criteria for a Green ICT maturity model?

Pöppelbuß & Röglinger (2011) state the key question: 'Which Design Principles are helpful to make a maturity model useful for its intended application domain and purpose of use? At the start of their research, their answer was 'To the best of our knowledge, there are no such Design Principles and no corresponding classification'. Becker (2009) and Pöppelbuß (2011) conducted research on this topic and provide complementary approaches for the design and validation of maturity models.

Becker's Requirements for Maturity Models

Over the past 20 years, over a hundred maturity models were developed to support ICT management. The procedures and methods that led to these models were not properly documented. Becker (2009) derived requirements and a procedure model from Hevner's design science guidelines. They distinguish eight phases that provide 'a manual for the theoretically founded development and evaluation of maturity models.' Becker chose Hevner's guidelines to establish reasonable requirements for the design of maturity models – all of these guidelines should be used when developing new maturity models (Wendler, 2012). In Table 7, the requirements are listed used to compare maturity models. Becker (2009) posits that maturity models are artefacts which serve as a basis for determining a company's status quo of its capabilities and deriving measures for improvement. This thesis proposes to use Becker's requirements as criteria for Green ICT Maturity Models.

Table 7. *Becker's Maturity Model Requirements (Becker et al., 2009)*

Becker's Maturity Model Requirements	
R1 – Comparison with existing maturity models	New model development to be substantiated by a comparison with existing models
R2 – Iterative procedure	Models must be iteratively proposed, refine, evaluated and enhanced
R3 – Evaluation	Principles, premises for development, usefulness, quality and effectiveness of the maturity model to be evaluated iteratively
R4 – Multi-methodologic procedure	Development of maturity model employs variety of research methods which need to be well founded and attuned
R5 – Identification of problem relevance	Demonstrate the relevance of the problem solution
R6 – Problem definition	The application domain, conditions for its application and the intended benefits of the maturity model, must be pre-determined prior to design
R7 – Target presentation of results	Presentation targeted with regard to conditions of its application and the needs of its users
R8 – Scientific documentation	Design process of the maturity model needs to be documented in detail

Pöppelbuß' Maturity Model Design Principles

Numerous shortcomings have been disclosed referring to both maturity models as design products and the process of maturity model design. Whereas research has already substantiated the

design process, there is no holistic understanding of the principles of form and function – that is, the design principles – maturity models should meet. Pöppelbuß and Röglinger (2011) proposed a pragmatic framework for maturity models, with three types of design principles: basic design principles, design principles for descriptive purpose of use (for as-is evaluations) and design principles for prescriptive purpose of use (for an improved future state). Table 8 lists Pöppelbuß nine main design principles, divided into 26 design subprinciples. This thesis proposes to use Pöppelbuß' design principles as criteria for Green ICT Maturity Models.

Table 8. *Pöppelbuß Design Principles for Maturity Models* (Pöppelbuß & Röglinger, 2011)

Group	Design Principles	
(1) BASIC	1.1	**Basic information** a) Application domain and prerequisites for applicability b) Purpose of use c) Target group d) Class of entities under investigation e) Differentiation from related maturity models f) Design process and extent of empirical validation
	1.2	**Definition of central constructs related to maturity and maturation** a) Maturity and dimensions of maturity b) Maturity levels and maturation paths c) Available levels of granularity of maturation d) Underpinning theoretical foundations with respect to evolution and change
	1.3	**Definition of central constructs related to the application domain**
	1.4	**Target group-oriented documentation**
(2) DESCRIPTIVE	2.1	**Intersubjectively verifiable criteria for each maturity level and level of granularity**
	2.2	**Target group-oriented assessment methodology** a) Procedure model b) Advice on the assessment of criteria c) Advice on the adaptation and configuration of criteria d) Expert knowledge from previous application
(3) PRESCRIPTIVE	3.1	**Improvement measures for each maturity level and level of granularity**
	3.2	**Decision calculus for selecting improvement measures** a) Explication of relevant objectives b) Explication of relevant factors of influence c) Distinction between an external reporting and an internal improvement perspective
	3.3	**Target group-oriented decision methodology** a) Procedure model b) Advice on the assessment of variables c) Advice on the concretization and adaption of the improvement measures d) Advice on the adaptation and configuration of the decision calculus e) Expert knowledge from previous application

Green ICT attributes

Maturity models have become a common tool for organisations to assess their capabilities in a variety of domains. It can be difficult to create or evolve a maturity model that features all the important aspects in a field or sector. Green ICT maturity models provide insight into the important aspects of an organisation to try to improve the social and environmental impact of ICT. The field of Green ICT maturity model research is still relatively new. Researchers are still consolidating maturity models, while systematically assessing and improving sustainable ICT capabilities within

organisations. It takes time and many iterative improvements for a Green ICT maturity model to come of age. The list of important aspects of a Green ICT maturity model continues to evolve.

On previous comparison studies of maturity models, Lautenschutz et al. (2018) agree it is a rational approach to define a list of attributes and assess each maturity model, to map the main attributes of each maturity model and to draw conclusions by performing a qualitative analysis on the results of the comparison. These comparison approaches are domain-specific, making it difficult to apply in a different domain. No method is specified for performing the model comparison and improvement of the model based on missing attributes.

To address this, Lautenschutz et al. (2018) developed a research method for comparison of Green ICT Maturity models called 'the Process Deliverable Diagram technique'. Seven Green ICT models were compared using a pivot maturity model (SURF GIMM) to systematically compare the attributes of each maturity model with respect to the attributes of the pivot model. While comparing the attributes, a matrix was constructed. The matrix supports the comparison and presents the result. Figure 3 summarises this result in a diagram of domains and attributes. The SURF GIMM (Hankel et al., 2014) was used as the pivot model and will also be used as the basis for this research. Additional attributes from the six maturity models (other than SURF) were identified through the comparison, but some had overlap with other attributes so these were not used. Molla's G-readiness attributes were included (Lautenschutz et al., 2018).

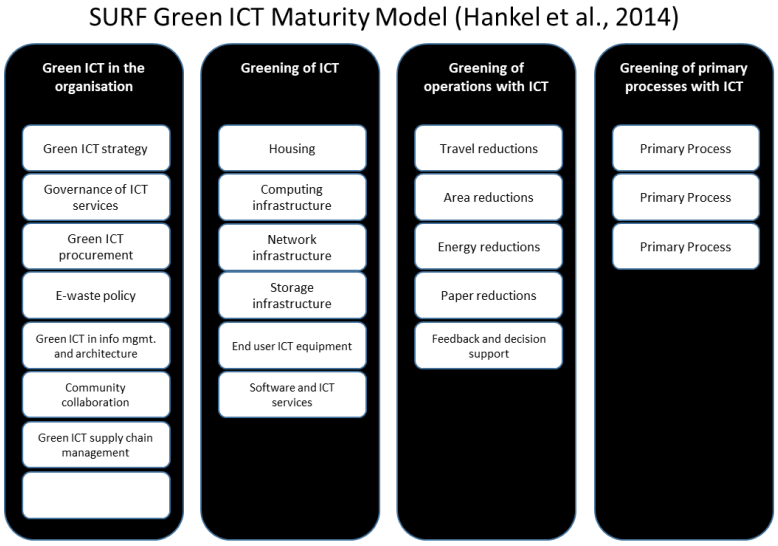


Figure 3. Green ICT Domains and Attributes

For this thesis, the criteria for a Green ICT maturity model are:

- Becker's Maturity Model Requirements (see Table 7)
- Pöppelbuß' Maturity Model Design Principles (see Table 8)
- Green ICT maturity model domains and attributes (per Figure 3).

3.3.4. L4. Which criteria are required to assess a Green ICT maturity model for the insurance sector?

Green ICT maturity models are generic in nature and are not specific to any industry or domain. The criteria from section 3.3.3 can be used as a starting point to assess a Green ICT maturity for the insurance sector. The attributes for 'Greening of primary business processes' will be added for the insurance sector as sector specific criteria (see section 2.2.2).

3.3.5. L5. From literature, are there suitable Green ICT maturity models for the insurance sector?

During the literature search for this thesis no Green ICT Maturity Models were found specifc to the insurance sector. Lautenschutz et al. (2018) and Hubers (2019) identify a total of nine Green ICT maturity models. These are listed in Table 9 in columns 1, 2 and 3 (Appendix 7 summarises the key characteristics of each of these Green IT maturity models). In Table 9, in columns 4, 5, 6, and 7, using the criteria identified in section 3.3.3, a set of assessment criteria helps assess and validate the maturity models, and help select a maturity model for the insurance sector.

In Appendix 8, the nine Green ICT maturity models are assessed for adherence to Becker's requirements and Pöppelbuß' principles in a qualitative manner. The more criteria and design principles used by the maturity model, the better the overall score. Table 9 summarises the results of Appendix 8 in column 4 and 5. The SURF Green ICT Maturity Model and the Green ICT Readiness framework meet most of Becker's requirements and Pöppelbuß's design principles. These two models will be used as the basis for the Green ICT maturity model for the insurance sector (GIMMi), and further enhancement of the model will be considered.

Table 9. *Assessment of Green ICT Maturity Models for Insurance*

Model #	Maturity Model	Researcher and date	Becker's require-ments	Pöppel-buß's design principles	SURF GIMM attributes	Additional attributes	Total score
1	SURF Green ICT Maturity Model	(Hankel et al., 2017)	8	6	26	0	40
2	Green ICT Readiness framework	(Molla & Cooper, 2010)	8	6	13	6	33
3	Green ICT framework and capability maturity model	(Philipson, 2010)	3	2	10	2	17
4	Capability Maturity framework for Sustainable Information and Communication technology	(Curry & Donnellan, 2012)	3	2	18	2	25
5	Green ICT Maturity Model for Czech SMEs	(Buchalcevova, 2015)	5	6	14	5	30
6	Governance and Management Framework for Green ICT	(Patón-Romero et al., 2017)	2	4	8	2	16
7	Practice oriented Green IS framework	(Butler, 2011)	2	4	15	6	27
8	Holistic approach to Green ICT	(Murugesan & Gangadharan, 2012)	2	4	13	3	22
9	Green ICT framework for greening Datacenters	(Uddin & Rahman, 2012)	2	4	7	5	18

In Appendix 9, the comparison matrix of Lautenschutz et al. (2018) was used as a starting point. The comparison matrix was enhanced by

- adding the first column with the domains and attributes from Figure 3,
- adding the primary insurance processes as attributes and
- adding two maturity models, 5. Green ICTMM for Czech SMEs and 6. Governance and Management Framework for Green ICT.

The enhanced comparison matrix will compare nine Green ICT maturity models to the attributes of column 1 of Appendix 9. Table 9 summarises the results of Appendix 9 in columns 6 and 7. The qualitative comparative results show that the 'SGIMM SURF Green ICT maturity model' (model 1), the 'G-readiness framework' (model 2), 'Capability Maturity framework for Sustainable Information and Communication technology' (model 4), and the 'Practice oriented Green IS framework' (model 7) have the best coverage for the SGIMM attributes and the additional attributes. Each of the nine models puts the emphasis on different attributes and misses attributes present in the other models. None of the models are all encompassing. Combining attributes from all nine models will make a Green ICT maturity model for insurance more comprehensive and more complex. Some attributes will not be included or will be missing and other attributes are subject to frequent evolution (Lautenschutz et al., 2018). The empirical research will validate if the added attributes are valued additions.

The nine Green ICT maturity models were compared, and assessed on Becker's criteria, Pöppelbuß' design principles and Green ICT domains and attributes. Total scores were added in the last column of Table 9, by adding the values of columns 4, 5, 6 and 7. Two models scored highest: the SURF GIMM model with a score of 40 and G-Readiness model with a score of 33. They address:

- Becker's criteria in general, however, G-Readiness is not developed iteratively which makes SGIMM a better model as it has been improved over time
- Pöppelbuß' design principles adherence
- The Green ICT domains and attributes: first 18 attributes are addressed well by both, SURF model scored on the primary insurance process attributes. The G-Readiness framework does not do this well.

Additional literature research identified 4 attributes not covered by the nine maturity models from Table 9. They will be added to the insurance maturity model:

- E-waste reuse, recycle and disposal attributes (Lansink, 1979)
- Radiation emissions management attribute (Russell, 2018)

The other 7 models don't compare well when all of Becker's criteria, Pöppelbuß' design principles and the Green ICT domains and attributes are considered. In summary, a suitable GIMMi therefore comprises:

- the SURF Green ICT maturity model (SGIMM), primary insurance process attributes were added, which would form a good basis for empiral research. It is further described and enhanced in 3.3.6.
- the G-readiness model attrinutes show whether organisations are ready in terms of attitude, policy, practice, technology and governance - results of a maturity scan can be used to identify potential bottlenecks for the adoption of Green ICT (Hankel et al., 2017).
- Supplemented with additional attributes from the other seven maturity models (Lautenschutz et al., 2018), specifically People and Culture (Curry & Donnellan, 2012), Corporate Social

Responsibility and Green Data Centres (Molla et al., 2011), Green Energy Sources (Butler, 2011), Green standards and metrics (Murugesan & Gangadharan, 2012), and Green house gas emissions (Philipson, 2010; Uddin & Rahman, 2012)

- Supplemented with E-waste attributes and the Radiation attribute.

3.3.6. L6. How to define and describe a relevant Green ICT maturity model for the insurance sector?

With a suitable GIMMi in section 3.3.5, figure 4 show the model (colour shows the source of the attribute, per the legend) and table 10 provides descriptions of the sections of the model. An GIMMi measurement tool is based on the domains and attributes of this model and will be used by respondents to score their organisation on Green ICT maturity for domains and attributes.

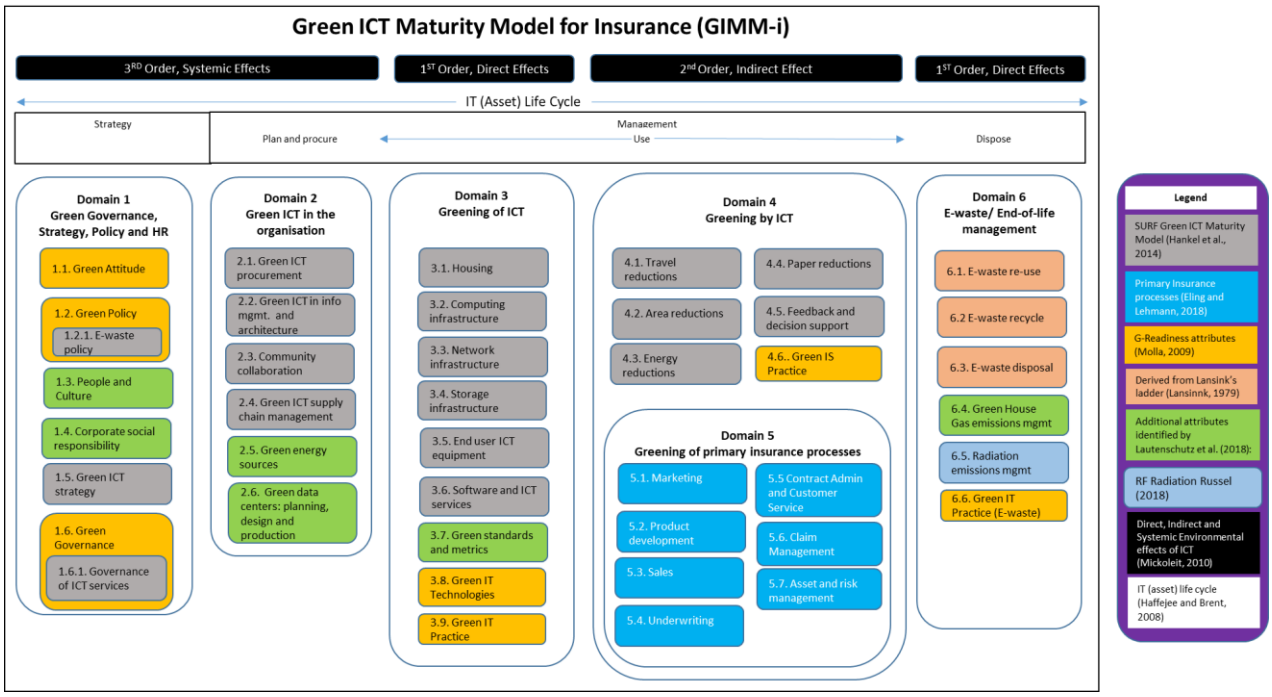


Figure 4. Sources for Green ICT Maturity Model (GIMMi) for the Insurance Sector

Table 10 provides descriptions for the domains and attributes; the Environmental Effects of ICT and the IT Asset Life Cycle and references are included for each line item.

Table 10. *Sections on the Green ICT Maturity Model*

How was the maturity model built up	Domains and Attributes derived or sourced from
Six Domains	
Domain 1 – Green Governance, Strategy, Policy and HR	• SURF model's Domain 1, attributes 1.2.1, 1.5 and 1.6.1 • Attributes 1.3, People and Culture (Donnellan et al., 2011) and 1.4, CSR (Molla & Cooper, 2010), identified by Lautenschutz et al. (2018) • Attributes 1.1, 1.2 and 1.6 from the G-readiness model: attitude, policy, governance
Domain 2 – Green ICT in the Organisation	• SURF model's Domain 1, attributes 2.1, 2.2, 2.3 and 2.4 • Attributes 2.5, Green Energy Sources (Butler, 2011) and 2.6, Green Data Centres (Molla & Cooper, 2010), identified by Lautenschutz et al. (2018)

How was the maturity model built up	Domains and Attributes derived or sourced from
Domain 3 – Greening of ICT	• SURF model's Domain 2, attributes 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6 • Attribute 3.7, Green Standards and Metrics (Murugesan & Gangadharan, 2012), identified by Lautenschutz et al. (2018) • Attributes 3.8 and 3.9 from the G-readiness model
Domain 4 – Greening by ICT	• SURF model's Domain 3, attributes 4.1, 4.2, 4.3, 4.4 and 4.5 • Attribute 4.6 from the G-readiness model
Domain 5 – Greening of Primary Insurance Processes	• SURF model's Domain 4 (which has no content) • Attributes 5.1 to 5.7 for the primary insurance process from Figure 1 in Section 2
Domain 6 – E-waste – End-of-Life Management	• ICT waste management attributes 6.1, 6.2 and 6.3 were derived from Lansink's ladder (Lansink, 1979) • Attribute 6.4, GHG emissions (Philipson, 2010; Uddin & Rahman, 2012), identified by Lautenschutz et al. (2018) • Attribute 6.5 identified by Russel (2018) • Attribute 6.6 from G-readiness model
Environmental Effects on the top in back boxes: Section 2.2.4 and 3.3.1 introduced the terms direct, indirect, and systemic effects of ICT, or 1st, 2nd, and 3rd order effects. The proposed model aligns and organises the domains and attributes identified in section 3.3.5 with 1st, 2nd, and 3rd order effects. Figure 4 shows this in the top of the diagram in black.	
Direct and 1st order effects are about Greening of ICT, which covers the use of ICT equipment and ICT waste management (aligned with Domains 3 and 6)	From Figure 2 in Section 3 (Mickoleit, 2010)
Indirect and 2nd order effects are about Greening by ICT, the application and use of ICT to increase the positive impact from using ICT to optimise business processes (aligned with Domains 4 and 5)	From Figure 2 in Section 3 (Mickoleit, 2010)
Systemic and 3rd order effects are about behavioural and structural changes, policies and strategies and other behaviour to ingrain Greening into the organisation (aligned with Domain 1 and 2).	From Figure 2 in Section 3 (Mickoleit, 2010)
IT Life Cycle: The value of a Green ICT maturity model can be enhanced by linking the maturity level of an attribute to each phase of the IT (asset) life cycle (Haffejee & Brent, 2008) . The proposed model aligns and organises the attributes identified in section 3.3.5 with ICT lifecycle and shows when the attributes are relevant during the life cycle of ICT assets. Figure 4 shows this in the top of the diagram.	
ICT life cycle – Policy, Strategy – aligned with Domain 1	IT (asset) life cycle (Haffejee & Brent, 2008)
ICT life cycle – Management – Plan and Procure – aligned with Domain 2	IT (asset) life cycle (Haffejee & Brent, 2008)
ICT life cycle – Management – Use of ICT – aligned with Domains 3, 4 and 5	IT (asset) life cycle (Haffejee & Brent, 2008)
ICT life cycle – ICT Waste Management – aligned with Domain 6	IT (asset) life cycle (Haffejee & Brent, 2008)

The definition of each attribute is provided in Appendix 10.2, Table 29. The SURF model (SURF, 2015) provided the definitions of the attributes from the SURF model, and those highlighted in yellow were updated by the researcher. The definitions for the other attributes (from Table 10) were obtained from the literature references related to those attributes and these are highlighted in green. For the attributes related to Domain 5, the primary processes, sub-attributes, or sub-processes are listed in the definitions. Upon review of these definitions, the researcher does not think there is overlap between Domains and attributes.

In Table 11, the researcher provides simple descriptions of each of the maturity levels (Curry & Donnellan, 2012). These descriptions will be used with the GIMMi measurement tool. The intent was to use long form descriptions of each maturity level for each attribute like the ones provided with the SURF model (SURF, 2015). However, these would make the tool more difficult to use and the questions less straightforward and slower to answer. There is a risk to using Table 11 because scoring is simple and the complexities of the maturity level of an attribute may not be understood by a respondent to the measurement tool.

Table 11. *Maturity Level Descriptions (Curry & Donnellan, 2012)*

Score	Description	Explanation
0	No intention	Never thought about it, no awareness
1	Initial	Some awareness. Considered it, but not implemented
2	Replicable	Some ad hoc implementation, but no strategy
3	Defined	Formal programs have been defined, but implementation is immature
4	Managed	Methodical implementation of programs, with adequate measurement and management
5	Optimised	All activities are monitored and managed for optimal performance. 'Best practice'

Figure 15 in Appendix 10.2 shows a black and white version of the Green ICT maturity model for the insurance sector without legend/ references.

The GIMMi measurement tool is used to measure the overall, domain and attribute maturity of the organisation. The definitions of each of the attributes were used to define one or more questions relating to each attribute and for Domain 5 sub-attributes. The available scores for each question are shown in Table 11. For simplicity and ease of use, the Table 11's scores of 0 and 1 will be maturity level 1, score 2 is maturity level 2, etc. The maturity level of a domain is determined by adding the scores of each of its attributes divided by the number of attributes (equally weighted). The maturity level of an attribute is determined by adding the scores of each of the questions for an attribute and its sub-attributes divided by the number of questions (equally weighted). The maturity level of a sub-attribute is determined by adding the scores of each of the questions for a sub-attribute divided by the number of questions (equally weighted) (Saunders, Lewis, & Thornhill, 2016, p.528).

3.4. Objective of the Follow-up Research

In section 4 to 6, empirical research will be done to answer the questions: *Is the proposed Green ICT maturity model for the insurance sector effective in measuring maturity in the insurance sector? Is the model complete, relevant, and usable in the insurance sector? What is the maturity level of the casus organisation?*

This questions will be answered by means of a single case study through a semi-structured interview (to be detailed in section 4) using the interview questions in Table 12 below and a maturity measurement tool to measure the green ICT maturity level of the respondent's organisation:

- GIMMi measurement tool: The GIMMi will be tested, measuring the maturity of the organisation. The results from the respondent's scores will be tallied and discussed with the respondent. These results will indicate the maturity of the organisation. The GIMMi measurement tool is included in Appendix 10.5.
- Interview Question list: The respondents will also be asked to answer questions for their organisation. The question list is included in Table 12 below. The E0 questions are used to select the target organisation and its respondents for the empirical research. The E1-E4 questions are

the actual interview questions for the respondents. The question answers will be transcribed, tallied, and discussed with the organisation.

Table 12. Interview questions for Empirical Research

Empirical questions	Interview questions for the respondents	How	Why required
E0. Who are the representative respondents?	E0.1. Is the organisation representative for the insurance sector?	Public documents on the internet	The researcher needs to ensure that the research results can be applied to the insurance sector.
	E0.2. Who in the case organisation has the knowledge and background to critically evaluate the GIMMI and complete the GIMMi measurement tool?	Group discussion and/ or Informal conversations with interviewees	Green ICT applies to the whole organisation and to ICT specifically. The participants must have experience and exposure to the Green ICT domains to ensure that quality results can be achieved from applying the model
E1. Is an insurance Green ICT maturity model effective in measuring Green ICT maturity in the insurance sector?	E1.1. Was the GIMMI measurement tool clear on what aspects of Green ICT maturity was being measured? If yes, what are the strong points? If not, what needs to change to make it clearer?	Semi-structured interviews	It is important for the participants to reflect on the experience and provide critical feedback on where the measurement tool is lacking clarity
	E1.2. Were you able to complete the GIMMi measurement tool in under 1 hour? If yes, how long did it take you? If not, what needs to change to complete the measurement in less than 1 hour?	Semi-structured interviews	It is important for the participants to reflect on the experience and provide critical feedback on completing the measurement in a timely manner
	E1.3. Is the measurement tool easy to use and is it inviting to fill out? If not, what needs to change to improve its usability?	GIMMi measurement tool	The persons must be sufficiently motivated (and not deterred) to fill in the model completely in an easy manner, as this will be used by multiple people at various levels in multiple insurance organisations
	E1.4. Do you think the GIMMI measurement tool is effective to assess green ICT maturity in your organisation? If yes, what are the strong points? If not, what needs to change to make it more effective?	Semi-structured interviews	It is important for the participants to reflect on the experience and provide critical feedback on why the measurement tool would or would not work well in the insurance sector
E2. Does the proposed insurance Green ICT maturity model need to be changed to measure maturity?	E2.1. Are the presented domains sufficient? Are more domains required? Or do we need to combine any domains? Is domain 4 useful? Please provide an explanation for your responses.	Semi-structured interviews	In the future, the model will be used to measure the Green ICT maturity of other insurance organisations. For the validity of the model it is important to ensure that all important components are in the model, that the components are logical and belong side-by-side and together form a complete model, and that non-relevant components have been deleted
	E2.2. Are the attribute definitions clear and complete? If not, which attributes need to be changed? Which attributes need to be added or combined or moved to another domain? Do the attributes cover all Green IT aspects required for the insurance sector? Which attributes do not add value and can be removed?	Semi-structured interviews	In the future, the model will be used to measure the Green ICT maturity of other insurance organisations. For the validity of the model it is important to ensure that all important components are in the model, that the components are logical and belong side-by-side and together form a complete model, and that non-relevant components have been deleted
	E2.3. Is the use of a 5 maturity levels appropriate to quantify the	Semi-structured interviews	To ensure reliable results, it is important that the definitions and descriptions are

Empirical questions	Interview questions for the respondents	How	Why required
	attributes? Are the maturity level descriptions for each attribute clear and complete?		clear and complete, and not open to interpretation
	E2.4. Does every domain and attribute need to be weighed against the other domains, within domains, and if so, what are suggested weightings? Or is each domain equally weighted/important? Is each attribute within a domain equally weighted/ important?	Semi-structured interviews	To ensure reliable results, it is important that the definitions and descriptions are clear and complete, and not open to interpretation
	E2.5. Is the model current? If not, what is missing or need to be changed? How does the model need to develop (over time): more or different domains, more or different attributes, other maturity levels? Will the model be usable over the next 3, 5, 10 years?	Semi-structured interviews	The model (and/or its components) needs to be up-to-date and not prone to become obsolete as it will be used multiple times in the future by multiple insurance organisations.
	E2.6. Can you think of any other factors why is the proposed model is (not) appropriate for use in the insurance sector?	Semi-structured interviews	The insights of the respondents validate if the proposed model can be applied in the insurance sector
E3. Does an insurance Green ICT maturity model provide impacts and insights in (lack of) the maturity of the organisation?	E3.1 Does the model provide a clear and complete picture of the Green ICT maturity of the organisation? If yes, what are the model's strengths? If not, what is missing or what needs to change? Or does it highlight a lack of maturity?	Semi-structured interviews	The model must provide insights in the maturity of the organisation. The model is being applied in the insurance sector and it is important to ascertain that the model works in the insurance sector (with or with modifications)
	E3.2 Does the model provide insights in the organisation's Green ICT maturity? If yes, what are the key insights? If not, what gaps in maturity exist?	Semi-structured interviews	The model must provide insights in the maturity of the organisation. The model is being applied in the insurance sector and it is important to ascertain that the model works in the insurance sector (with or with modifications)
E4. Can the maturity model results help define actions and improvements for Green ICT?	E4. 1 Are the results from the GIMMI measurements clear and complete? If yes, what did you like about the results? If not, what needs to change?	Semi-structured interviews	It is important to ensure that the model can provide actions and improvements for Green ICT in the insurance sector
	E4.2 Do the results imply or trigger actions to question maturity levels, do additional research and/or help address improvement of maturity levels? If yes, which actions? If not, where is improvement required?	Semi-structured interviews	It is important to ensure that the model can provide actions and improvements for Green ICT in the insurance sector
	E4.3 Do the results highlight or imply areas for improvement to improve maturity levels? If yes, which ones stand out? If not, what is missing or how can the results be improved?	Semi-structured interviews	It is important to ensure that the model can provide actions and improvements for Green ICT in the insurance sector
E5. What is the maturity of the case organisation?	None	GIMMi measurement tool	Measures the maturity of the casus organisation

4. Methodology

In section 3, the theoretical framework was developed for the research question '*Which Green ICT maturity framework can measure, evaluate, and improve the environmental impacts of ICT in the insurance sector?*' The result was the Green ICT Maturity Model for insurance (GIMMi), as shown in Figure 4, based on the SURF GIMM and G-readiness models (as described in section 3.3.6).

This section describes the empirical research to be conducted to test the GIMMi for completeness and use in the insurance sector. It provides the conceptual and technical design of the empirical research, details on the data analysis of the results and reflection on validity, reliability, and ethical aspects. The Design Science Research Method (DSRM) is used as it has been used to research information systems focused on the creation of successful models. The DSRM process has six activities. In Table 13 the six activities are listed and their role in the research process are explained (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). The last column of Table 13 describes the related sections in this report as well as the main findings.

Table 13. *Design Science Research Method (DSRM) activities*

DSRM activity	Description	Role in research	Section # and Finding
1	Problem identification and motivation	Define the specific research problem and justify the value of a solution.	See section 1.1 to 1.4. The insurance sector does not have a tool or framework to measure the maturity level of its Green ICT. Since measures are not available, clear, and comprehensive insights into the environmental footprint are not available and specific actions for improvement over time can't be determined.
2	Define the objectives for a solution	Infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible. The objectives can be quantitative, e.g., terms in which a desirable solution would be better than current ones, or qualitative, e.g., a description of how a new artefact is expected to support solutions to problems not hitherto addressed	Section 1.5 and 1.6. The research will select/develop a relevant Green ICT Maturity Model to measure and assess the positive and negative effects of ICT on the environment, and to provide recommendations to improve the effects of IT, so that insurers can achieve their sustainability goals and improve Green ICT maturity over time.
3	Design and development	Theoretical framework and objectives of empirical research. Create the artefact. Such artefacts are potentially attributes, models, methods, or instantiations (each defined broadly) [20] or 'new properties of technical, social, and/or informational resources [24]'. Conceptually, a design research artefact can be any designed object in which a research contribution is embedded in the design. This activity includes determining the artefact's desired functionality and its architecture and then creating the actual artefact. Resources required moving from objectives to design and development include knowledge of	See section 3 and specifically 3.3.6. The theoretical framework is based on GIMMi: • Aligned domains with the ICT lifecycle • Aligned domains with 1st, 2nd, or 3rd order Green ICT • SURF model's domains 1-3 • SURF model's Domain 4, adding insurance primary processes • Additional attributes such as people and culture • G-readiness model to see whether organisations are ready in terms of attitude, policy, practice, technology and governance • Enhanced with Lansink's e-waste attributes See section 3.4. The objective of the empirical research is to use the model to measure the Green ICT maturity of insurance companies and to determine if the proposed Green ICT maturity model for the insurance sector

DSRM activity	Description	Role in research	Section # and Finding
		theory that can be brought to bear in a solution.	(GIMMi) is complete, relevant, and usable in the insurance sector.
4	Demonstration	Results of the empirical research. Demonstrate the use of the artefact to solve one or more instances of the problem. This could involve its use in experimentation, simulation, case study, proof, or other appropriate activity	Section 5. Results of the empirical research. This research demonstrates the GIMMi model to the respondents. The respondents will fill in the GIMMi measurement tool and will be part of an interview in which they will answer the set of interview questions.
5	Evaluation	Discussion and reflection. Observe and measure how well the artefact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artefact in the demonstration. It requires knowledge of relevant metrics and analysis techniques.	Section 6. Comparison of the results of the empirical research with the design
6	Communication	Report and present. Communicate the problem and its importance, the artefact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences	Thesis document and (PowerPoint for) defence presentation

4.1. Conceptual Design: Select the Research Method(s)

The objective of the empirical research is to test the completeness and usability of the proposed model to measure Green ICT maturity in the insurance sector. The interview questions for the respondents are the empirical research questions and are listed in Table 12.

To determine the right choice for the research method, the Research Onion of Saunders was used. The research onion is a way of depicting the issues underlying the choice of the data collection method by peeling away the outer two layers of 'Research philosophy' and 'Approach to theory development'. These layers will influence the selections in the next three layers of the onion – methodological choice, research strategy and the time horizon for the research. The final layer is the techniques and procedures (Saunders et al., 2016). The choices for the six layers are summarised in Table 14. The remainder of section 4.1 provides the reasoning for the choices.

Table 14. *Choices for each layer of the Research Onion* (Saunders et al., 2016)

Layer	Choices
Research philosophy	Pragmatism
Approach to theory development	Combination of deduction (testing of an existing theory) and induction (development of a new theory)
Methodological choice	Mono-method qualitative
Research strategy	Case study of one organisation
Time horizon	Cross sectional, snapshot
Techniques and procedures	Semi structured interviews

Research philosophy – Choice is Pragmatism

Five research philosophies in business and management research are compared: positivism, critical realism, interpretivism, postmodernism and pragmatism (Saunders et al., 2016, p.135-144). The assumptions for pragmatism indicate a better research philosophy for the empirical research to be conducted than the ontology, epistemology, and axiology assumptions of the first four

philosophies. Improving practice is what this research wants to achieve and therefore pragmatism is the choice for this research.

Approach to theory development – Choice is deductions and induction

A research topic on which there is a wealth of literature for which a theoretical framework and a hypothesis can be defined, lends itself readily to deductive research. Deductive research can be relatively quickly to complete, time schedules can be predicted, and data collection can be based on a single take of interviews. Inductive and abductive research can be much longer to complete. If (a component of) the research is new with little existing research, it may be more appropriate to work inductively by generating data and analysing and reflecting upon what theoretical themes the data are suggesting (Saunders et al., 2016). This choice and dominant approach for this thesis is a deductive approach, supplemented by an inductive approach where the GIMMi is enhanced for the insurance sector.

Methodological choice – Choice is mono-method qualitative

Many business research designs combine quantitative and qualitative elements. Pragmatists also value qualitative and quantitative research and may be influenced by mixed/multiple methods research (Saunders et al., 2016). Even though the preference would be for 'multiple methods' research, due to the limited time available for this thesis, and since a new model was developed, the choice is a qualitative method. In addition, qualitative research is more suitable to get an overview – quantitative is more for depth.

Research strategy – Single case study

The key to the choice for a research strategy is to achieve a reasonable level of coherence through the research design, which will enable the answering of the research question(s) and objectives. This coherence will link to the philosophy, research approach and purpose, and more pragmatic concerns, such as the extent of existing knowledge, the amount of time and other resources available and access to potential participants and to other sources of data (Saunders et al., 2016). Given this context and the research question(s), a research strategy choice for this thesis would be a survey and/or case study of multiple organisations, but with the limited time available to complete this thesis, a case study of one organisation will need to suffice.

Time horizon – Choices are cross-sectional and snapshot

Is the research a snapshot taken at a particular time (cross sectional) or a series of snapshots over a given period (longitudinal)? (Saunders et al., 2016). Even though a longitudinal study would be preferable, due to time constraints, a cross sectional snapshot will have to suffice for this thesis.

Techniques and procedures – Choice is semi-structure interviews

The industry sector deals with large amounts of personal data and privacy and confidentiality are very important and heavily regulated. Sampling and access to secondary data are therefore unlikely options for data collection. Collecting primary data will be the choice for this thesis. Given the limited access and time available, collecting primary data through observation will not be possible. Collecting primary data through interviews and a GIMMi measurement tool will be the choice for this thesis. The research interview is a purposeful conversation between two or more people, requiring the interviewer to establish rapport and ask concise and unambiguous question, to which the interviewee is willing to respond, and to listen attentively. The interview gathers valid and reliable data relevant to the research question(s). Interviews are categorised as structured, semi-structured or unstructured. A semi-structured interview allows the researcher to have a list of themes and key questions, with the option to add, re-sequence or omit themes or questions to explore the research question(s) or prompt further discussion (Saunders et al., 2016). The formality

and flexibility of the semi-structured interview (in comparison to the structured or unstructured interviews) is preferred given the research topic and the limited time available for the research.

4.2. Technical Design: Elaboration of the Method

The steps to elaborate on the method include:

- Selection of the insurance company and key contact
- Selection of the candidate respondents
- Test of GIMMi measurement tool and Interview
- Pre-read and pre-interview tasks
- Interviews
- Post interview activities and enhancement of the model
- Potential follow-up items

These steps are described in detail in Table 15, including the timing and actor of each step.

Table 15. *Steps in the Empirical Research for this Thesis*

Step	Description	Who/Actor	Timing
Selection of the insurance company and key contact	The researcher of this thesis, as a former executive of and current consultant to the insurance sector, will reach out, by email and phone, to five CIOs or Executives at Canadian insurance companies (Key Contacts) to gauge their willingness to participate in the research during the period of February 1, 2020 to March 15, 2020. The email and phone call will provide details on the research question(s) and objectives, the interviews approach, the timing of the interviews, the confidentiality of the insurance company and the interview results and when the thesis will be completed. Based on the Key Contact responses, the student will select one insurance company as participant. The researcher will thank all Key Contacts.	Five Executives	Jan 23-30, 2020

Selection of the candidate respondents	The Green ICT model and its maturity levels developed in section 3.6 will be evaluated based on semi structured interviews. The number of interviews will be between five and seven (due to limited time available). Criteria have been documented to ensure that the respondents have the experience and qualifications with respect to Green ICT and maturity to contribute value to the research. The Key Contact will identify candidate respondents from ICT and the business based on the following criteria:
	• The respondent can quickly get an understanding of the subject matter
	  ○ The respondent has an academic education and/or a level of experience with ICT and business processes
	  ○ The respondent's willingness to be interviewed
	• The respondent knows and has experience in the insurance sector
	  ○ The respondent is an employee of the insurance company and have been in their role at least 2 years
	  ○ The respondent knows the ICT organisation in the insurance company
	  ○ The respondent is an ICT manager or is involved in sustainability/greening and strategy of the organisation
	• The respondent knows and has experience with the primary insurance processes
	  ○ One or two candidates each from
	  ○ ICT,
	  ○ from the Claims management business process,
	  ○ from the Sales and Underwriting business process, and
		Key Contact	Feb 1-5, 2020

Step	Description	Who/Actor	Timing
	○ from the Contract Administration and Customer Service business process Table 18 shows how each of the respondents met these criteria. Candidate respondents will be personally approached. The research outline and objectives will be provided. Candidate will be asked to participate in an interview. The introductory email is provided in Appendix 10.1. Once the candidate agrees, specific arrangements will be made, when and where the interview will happen, and how long the respondent's time commitment is for the pre-read information (background information, objective of the interview, the GIMMi, and the interview questions) and interview.		
Test of GIMMi measurement tool and interview	The pre-read information will be sent to a test respondent (a CIO in a Canadian Insurance company) on January 24, 2020 and will be requested to complete the pre-read and pre-interview tasks by January 28, so that the test interview can be completed by the end of January 2020. The pre-read information is included in Appendix 10.2. • background information which is a short description of the research and definitions of green, ICT, green ICT, and green ICT maturity model, • the proposed Green ICT Maturity Model, • objective of the interview and what is expected during the interview • the interview questions to be answered • what will be done with the results of the interview and GIMMi measurement tool and activity post interview • the GIMMi measurement tool (see Appendix 10.5), to be completed by January 28, 2020. The pre-read information will be updated with any findings or feedback from the test respondent. If some interview questions were not clear, those will be updated with better language. If the interview took too long, some questions may be eliminated or reworded.	Test respondent	Jan 24-28, 2020
Pre-read and pre-interview tasks	The pre-read information will be sent to the respondents at least one week before the interview, during the week of February 10, 2020. The pre-read information is included in Appendix 10.2. • background information which is a short description of the research and definitions of green, ICT, green ICT, and green ICT maturity model, • the proposed Green ICT Maturity Model, • objective of the interview and what is expected during the interview • the interview questions to be answered • what will be done with the results of the interview and GIMMi measurement tool results and activity post interview • the GIMMi measurement tool (see Appendix 10.5). Each respondent will fill in the GIMMi measurement tool by February 20, 2020. The results will be kept confidential. The expectation is that the respondent is prepared for the interview, has completed the GIMMi measurement tool, and has read through all the materials provided. To make the interview anonymous, each respondent will be assigned a number and all documentation will refer to the respondent number.	Respondents	Feb 17-24, 2020
Interviews	The interviews will take place during the weeks of February 17 and 24, 2020, with backup week of March 2, 2020. The interviews will take place at the respondent's office location (backup is a skype call with video). With the respondent's permission, the interview will be recorded. Notes will be taken. A walkthrough of the model and the interview questions will be completed during the interview. The respondent will be asked for clear, concise, and well-articulated responses. Section 3.4 will be used as guideline for the interview. Since the interview questions are open	Respondents	Feb 24-Mar 9, 2020

Step	Description	Who/Actor	Timing
	questions, the respondent's answers may provide direction for follow-up questions.		
Post interview and Enhancement of the model	The interview will be transcribed, at a minimum documenting the key points and answers, and sent to the respondents for validation and correction and further details within 5 business days of the interview time. The email with this request is included in Appendix 10.3. This will also include any required follow up questions. The respondent will be asked to provide the validation within 5 business days. The interview transcripts will be finalised and used as input to the GIMMi enhancement. The results of the GIMMi measurement tool will be tallied and summarised. The summary will be shared with the respondents with the validation email. Specific actions and improvements to improve the maturity of the organisation's Green ICT will be highlighted and summarised. Based on the interview results, potential changes and/or enhancements to the model will be identified and assessed. If the potential changes are relatively minor in nature, the model will be updated, finalised, and shared with the respondents for their validation; the email with this request is included in Appendix 10.4. If significant changes are required, then recommendations for updates will be documented for re-validating the model in the future.	Respondents	Mar 2-15, 2020
Potential follow-up items	An attempt will be made to discuss the results of the interviews and the proposed enhanced model with the Key Contact and the respondents, as a group. This may be scheduled in April of 2020. This may not happen due to time constraints.	Respondents	April 2020

4.3. Data Analysis

The data analysis will start with documenting the answers for each interview question, summarised in key words, and assessed for relevance for enhancing the proposed GIMMi. These relevant answers will be placed in a matrix with the respondent's numbers on the top and interview questions on the left. The matrix will show similarities and differences between the respondent's answers. Based on these insights into the matrix, by relating the relevant answers across interviews and domains and looking for patterns, updates to the GIMM can be identified.

The responses to the GIMMi measurement tool will be summarised into graphs that show the maturity levels:

- Analysis by respondent (section 5.2.1)
- Analysis of highest and lowest maturity level for Domains and Attributes (section 5.2.2)
- Analysis of maturity levels related to the IT life cycle (section 5.2.3)
- Analysis of maturity levels related to direct, indirect, and systemic effects (section 5.2.4)

As a next step, once the full scope of the insights and updates to the GIMMi has been completed, recommendations for updating the model can be articulated and, if time allows, the model can be updated.

4.4. Reflection on Validity, Reliability and Ethical Aspects

The design chosen for this thesis is substantiated by assessing the validity, reliability and ethical aspects and reviewing the weaknesses of the choices. Validity refers to the appropriateness of the measure used, the accuracy of the analysis of results and the generalisability of the findings

(Saunders et al., 2016). Reliability is if the research were to be repeated, a similar result would follow.

4.4.1. Validity

If we take the (construct, internal, external) validity steps as a starting point, the core steps of empirical research are:

1. Use an approach to get data – the quality of the approach has considerable influence on the quality of the resulting data, which should give an accurate reflection of the actual situation (construct validity)
2. Draw conclusions from data – the line of reasoning from data to conclusion is as good as possible (internal validity)
3. Applicability of findings – the conclusions hold true beyond the direct environment of the research (external validity) (Saunders et al., 2016)

Construct validity

Construct validity is defined as the extent to which the measurement questions actually measure the presence of the constructs intended to be measured (Saunders et al., 2016). In this thesis we will follow a well-defined procedure to gather data, through a semi-structured interview (see section 4.1, 4.2 and 4.3). The actions in these sections to promote good construct validity include established chains of evidence (the respondents are identifiable and will be asked to correct the transcripts of the interviews) and review of draft version of the report by the respondents and professors guiding this thesis. Construct validity is weakened because multiple sources of evidence are not used and the correct operational measures for the concepts being studied have not be validated.

Internal validity

Internal validity is defined as the extent to which findings can be attributed to interventions rather than any flaws in the research design (Saunders et al., 2016). The first part of this thesis was completed using a scientific approach, which included a literature study of scientific research by multiple researchers using definitions, comparisons, and reviews of Green ICT maturity models (see Appendix 1, 5-9). One of these models, the SURF GIMM model, is used as a base for the proposed model for this thesis and has been validated in the education sector in the Netherlands (Hankel et al., 2014). The data will be collected from semi structured interviews. The respondents will be selected based on criteria (see section 4.2) and together they will represent the required knowledge and skills to make a relevant contribution to the proposed model.

The pre-read material is sent one week before the interview, which gives the respondent an opportunity to think about his/her responses ahead of time. The respondents will be provided with definitions of all terms (including domains, aspects within domains, and maturity levels) to ensure that each interview used the same definitions of terminology. The respondents used the GIMMi measurement tool to score the maturity of the attributes in the model. The respondents will be selected based on specific criteria. They are experts and their responses are of value to the research. The objective is that the interview results lead to an improvement of the model. The objective of the interviews is not to evaluate the performance of the respondent or the respondent's department with respect to Green ICT. Even though each respondent will have his/her own (strong) opinions about Green ICT, keeping the focus on the model and away from performance, using common terminology, should help keep the respondent's bias to a minimum. The semi-structured interview's format allows for follow up questions in case a strong bias is expressed.

External validity

External validity is defined as the extent to which the research results from a particular study are generalisable to all relevant contexts (Saunders et al., 2016). The ICT used by Canadian insurers, including the respondent's organisation, is serviced by a limited number of hardware, insurance software, cloud, and insurance services vendors. There is a (low) risk that the selected insurance company will not be representative of the Canadian insurance sector. The respondents will be selected based on specific criteria to ensure broad and varied expertise from the organisation. The external validity is lacking as this case study was done in the insurance sector and it has not been proven that it can be replicated to other sectors. The study can be done with other insurance companies which will strengthen validity within the sector.

4.4.2. Reliability

Reliability is defined as the extent to which the data collection technique or techniques will yield consistent findings, similar observations would be made, or conclusions reached by other researchers or there is transparency in how sense was made from the raw data (Saunders et al., 2016).

The approach for the literature research was documented in detail and completed per the plan. The approach and execution of the empirical research was documented in detail and executed per the plan. Six interviews will be conducted which will limit the impact of one respondent's statement on the overall results. The same questions will be asked in each interview - by combining the responses, the results of the interviews can be summarised and used to determine the relevance of the model. Responses will be validated by the respondents after they are transcribed, to address any misinterpretation or misunderstanding. Responses may be biased since the proposed model is used as a reference point, even though the respondents will be asked to validate the model and provided missing components.

In summary, the research is designed using a scientific approach, it is fully designed and described and can therefore by reproduced by another researcher.

4.4.3. Ethical aspects

The research and interviews will be completed in an ethically responsible manner: anonymity, same questions, documented results tracking, no (monetary) incentives to influence results, no hidden motives for the interviews (performance review), and no external (executive) influence on results. Saunders (2016) provides ethical principles for research. Table 16 provides the rationale for each of the aspects for this thesis.

Table 16. *Ethical Aspects of this Thesis*

Ethical principle (Saunders et al., 2016)	**Rationale for this thesis**
Integrity and objectivity of the researcher	The researcher will act openly, is truthful and promotes accuracy. No deception, partiality or promises will be made and conflicts of interest will be declared.
Respect for others	The rights of the respondents will be recognised. Responsibilities to those that take part will be recognised. The respondent will have the right to absence of coercion
Avoidance of harm	Any harm to respondents will be avoided – the respondents will not be embarrassed, discriminated, cause stress and put in a conflict situation
Privacy of those taking part	Privacy underpins all ethical principles. The respondents and organisation's privacy will always be ensured. The respondent will be

Ethical principle (Saunders et al., 2016)	**Rationale for this thesis**
	informed about recording the interview and has the option to decline the digital recording.
Voluntary nature of participation and right to withdraw	Respondents will not be forced or harassed into participating. Even if participating voluntary, the respondent has the right to withdraw and/or not respond to specific questions
Informed consent of those taking part	The respondent will understand the implications of participation (time commitment, recorded information) so he/she can reach an informed decision about whether to participate
Ensuring confidentiality of data and maintenance of anonymity of those taking part	Respondents and the organisation will be anonymous. Confidentiality will be respected strictly. The intent is to keep the respondents and the respondent's company and the results anonymous in the thesis report. The focus is on improving the model not on evaluating the performance of the organisation with respect to Green ICT. All confidential information will be available to the thesis evaluation team at the Open Universiteit Nederland.
Responsibility in the analysis of data and reporting of findings	Privacy, anonymity, and confidentiality will be upheld when reporting data. Findings should be reported fully and accurately, even if they contradict expected outcomes. Interpretations of the results should be checked carefully. The organisation and respondents have a right to quality research and will be debriefed.
Compliance in the management of data	No personal data will be captured. Legal restrictions and regulations related to the management of research data will be complied with
Ensuring the safety of the researcher	Risk of physical threat or being in a compromising situation will be assessed and avoided.

5. Results

This section outlines the implementation of the research:

- how the interview process deviated from the plan
- how the interview responses and measurement results were processed and
- how the empirical research questions E1 to E5 from Table 12 were addressed?

5.1. Deviations from Planned Steps

Table 15 presented the planned steps for the empirical research. Table 17 outlines the deviations from these planned steps.

Table 17. *Deviations from Planned steps for the Empirical Research for this Thesis*

Step	Planned steps from *Table 12*	Deviations
Selection of the insurance company and key contact	Reach out, by email and phone, to five CIOs or Executives at Canadian insurance companies (Key Contacts) Based on the Key Contact responses, the student will select one insurance company as participant. The student will thank all Key Contacts.	Reached out to 10 Executives and Managers None of the executives were willing to provide up to 7 people from one company for the research – key reason: too busy with projects and implementing their 2020 plans
Selection of the candidate respondents	The number of interviews will be between five and seven (due to limited time available). The Key Contact will identify candidate respondents from ICT and the business based on the following criteria: • Understanding of the subject matter: academic education and/or a level of experience with ICT and business processes; willingness to be interviewed • experience in the insurance sector; knows the ICT organisation in the insurance company; involved in sustainability/greening and strategy of the organisation • experience with the primary insurance processes: ICT, Claims management, Sales and Underwriting, Contract Administration and Customer Service Candidate respondents will be personally approached; specific arrangements will be made	Six of the executives/ managers were willing to participate in the research, from 5 companies, 2 from business and 4 from IT, and 4 from Property and Casualty insurance (Auto and Home) and 2 from Life insurance companies. The selection criteria from Table 15 were used. All six respondents understood the subject matter and had years of experience in the insurance sector. The respondents from business did not have detailed knowledge of the IT (greening) processes and the respondents from IT did not have detailed knowledge of the business (greening) processes. The following data on meeting the selection criteria for each respondent were obtained from the interviews and the researcher's knowledge of the respondents. Table 18 shows the assessment of how respondents met the selection criteria. Figure 5 shows the domain expertise for each respondent. Respondents were interviewed by video conference or in person and appointments were set up to accommodate the respondents' calendar.
Test of GIMMi measurement tool and interview	The pre-read information will be sent to a test respondent (a CIO in a Canadian Insurance company) The pre-read information will be updated with any findings or feedback from the test respondent. If some interview questions were not clear, those will be updated with better language. If the interview took too long, some questions may be eliminated or reworded.	Executed according to plan - some minor edits to the pre-read information and questions were completed to address areas that required clarification
Pre-read and pre-interview tasks	The pre-read information will be sent to the respondents	Executed according to plan. All respondents were prepared, completed the measurement tool and were assigned a number.

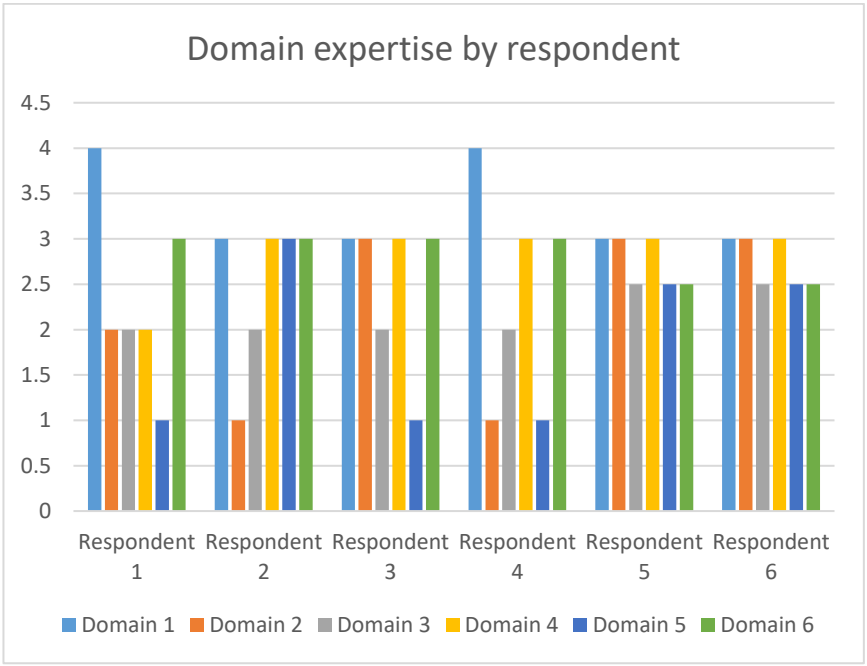
Step	Planned steps from *Table 12*	Deviations
	The expectation is that the respondent is prepared for the interview, has completed the GIMMi measurement tool, and has read through all the materials provided. To make the interview anonymous, each respondent will be assigned a number and all documentation will refer to the respondent number.	
Interviews	The interviews will take place during the weeks of February 17 and 24, 2020. The interviews will take place at the respondent's office location (backup is a skype call with video). With the respondent's permission, the interview will be recorded. Notes will be taken. A walkthrough of the model and the interview questions will be completed during the interview. The respondent will be asked for clear, concise, and well-articulated responses. Section 3.4 will be used as guideline for the interview.	The interviews were delayed by two weeks since it took longer to find respondents. Interviews took place through Facetime (1), at Starbucks (4) and at the respondent's office (1). 5 of the 6 interviews were recorded – notes were taken. All interviews were completed in about 60 minutes – respondent 4 and 6 took 10 minutes longer. A detailed walkthrough of the model did not happen in all 6 interviews as all respondents had reviewed the pre-read materials and communicated that they clearly understood the model. All interview questions (section 3.4) were addressed in all interviews.
Post interview and Enhancement of the model	The interview will be transcribed, at a minimum documenting the key points and answers, and sent to the respondents for validation and correction and further details The results of the GIMMi measurement tool will be tallied and summarised. The summary will be shared with the respondents with the validation email. Specific actions and improvements to improve the maturity of the organisation's Green ICT will be highlighted and summarised. Based on the interview results, potential changes and/or enhancements to the model will be identified and assessed. If the potential changes are relatively minor in nature, the model will be updated, finalised, and shared with the respondents for their validation; the email with this request is included in Appendix 10.4. If significant changes are required, then recommendations for updates will be documented and re-validated in the future.	Interviews were transcribed and summarised with key points (Appendix 11). In yellow is information that is relevant to the research results. In green is information that could be cited in the thesis report. The transcripts were sent to all respondents for validation – 5 respondents acknowledged that the interview summary reflected what was discussed and required no changes; one respondent did not respond. Results were tallied and summarised. The overall results have not been shared with the respondents. The four types of analysis identified in section 4.3 were completed. As the respondents of this research were extended from one company to 5 companies, from P&C and Life insurance, the researcher added a 5th type of analysis to highlight the differences between maturity in P&C and Life insurance sectors (section 5.2.5). The matrix with key points from the interview is included as Appendix 11 (In yellow is information that is relevant to the research results. In green is information that could be cited in the thesis report) and will be used for further analysis in section 6 - a summary of this matrix is included as Table 20. As part of section 6, model updates, specific actions and improvements will be highlighted. This has not been shared with the respondents.
Potential follow-up items	An attempt will be made to discuss the results of the interviews and the 'proposed' enhanced model with the Key Contact and the respondents, as a group. This may be scheduled in April of 2020. This may not happen due to time constraints.	This will not be completed due to the physical distancing required due to COVID-19. This could have been completed in a group or individual video call with the respondents. The researcher did not have time to meet the deadlines for thesis submission to complete this video call.

Table 18 shows how respondents met the selection criteria. Table 18 shows that the respondents (mostly) met the selection criteria. The criteria do not relate directly to the Domains in the GIMMi. Figure 5 shows the relationship between the respondents and their knowledge of the Domains. Adding Figure 5 is a deviation from the steps and was added based on input from the respondents. They expressed they should not be considered experts for all domains.

Table 18. *How the Six Respondents met the Selection Criteria*

Criteria	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6
Quickly understand subject matter	Yes	Yes	Yes	Yes	Yes	Yes
Academic education	Yes	Yes	Yes	Yes	Yes	Yes
Experience with ICT and business processes	Yes	Yes	Yes	Yes	Yes	Yes
Willingness to be interviewed	Yes	Yes	Yes	Yes	Yes	Yes
Experience in insurance	Yes	Yes	Yes	Yes	Yes	Yes
At least 2 years	Yes	Yes	Yes	Yes	Yes	Yes
Knows ICT	Yes	Yes	Yes	Yes	Yes	Yes
Is ICT manager or involved in greening	Yes	Yes	No	Yes	No	Yes
Knows primary insurance processes	Yes	Yes	Yes	Yes	Yes	Yes
ICT	Yes	Yes	No	No	Yes	No
Claims	No	No	Yes	Yes	Yes	Yes
Sales and UW	No	No	Yes	Yes	No	No
Contract admin	No	No	Yes	Yes	Yes	No

Figure 5 shows the domain expertise for each respondent. Based on the interviews and input from respondents, the researcher developed an indication for the experience level for each domain for each respondent.



Experience levels are defined as:
1 = no knowledge
2 = some knowledge
3 = good knowledge
4 = expert

Figure 5. Domain Expertise for the Six Respondents

5.2. Results for Question E5. What is the maturity of the cases organisations?

5.2.1. Analysis by respondent

Each of the respondents completed the measurement tool. Figure 6 shows the maturity levels by respondent by domain, and the maturity level by domain (section 3.3.6 describes how the maturity levels will be calculated). It shows that Domain 4 is most mature across all respondents. The graph shows that the Respondents 1 to 4 from the P&C insurance sector scored lower than the two respondents 5 and 6 from the Life insurance sector. Respondent 1 has the highest maturity level with Domain 4. Respondent 5's organisation has the highest maturity levels for Domain 1 and 4.

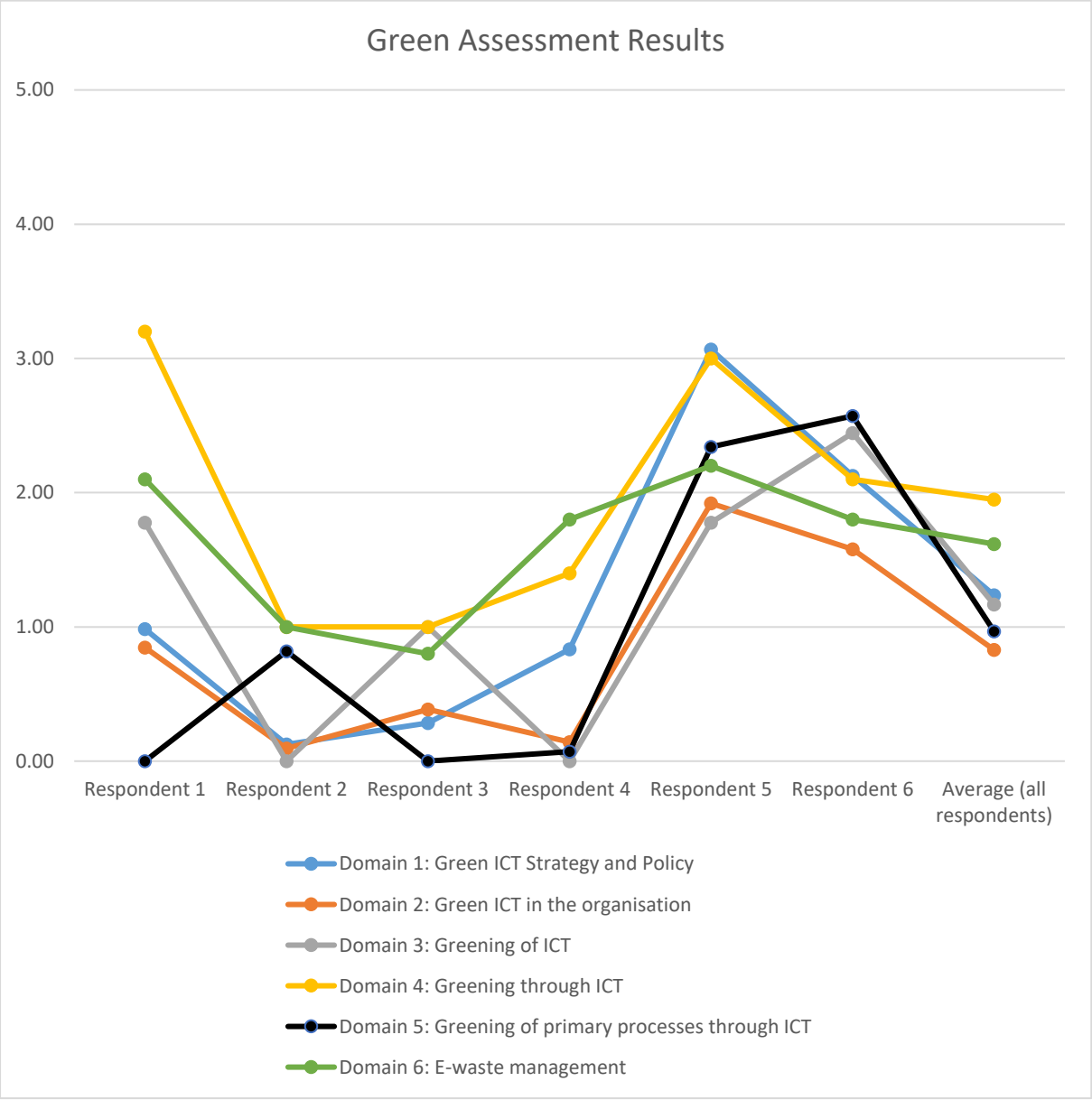


Figure 6. Green ICT Maturity Results by Domain for Six Respondents

5.2.2. Analysis of highest and lowest maturity levels for Domains and Attributes

Appendix 12 has four tables and provides more detailed analysis of the maturity scores for the model attributes, from three perspectives – the insurance sector and the P&C insurance and the Life Insurance sub-sectors. Table 19 summarises Appendix 12.

Table 19. *Highest and Lowest Maturity Levels*

Tables in Appendix 12	Tables show that
Table 34. Highest and lowest maturity by model attributes. This table has all of the model attributes and the highest and lowest maturity attributes for the insurance sector, and the P&C and Life subsectors are indicated.	• Domain 1 – Green Strategy and Policy - has some of the lowest maturity ratings for the P&C Insurance sector and some of the highest for the Life Insurance sector • Domain 2 – Green ICT in the organisation - has some of the lowest ratings for both the P&C and Life insurance sectors • Domain 3 – Greening of ICT – has moderate ratings for both the P&C and Life insurance sectors • Domain 4 – Greening through ICT – has high ratings for both the P&C and Life insurance sectors, for most attributes • Domain 5 - Greening of primary processes through ICT – has low ratings for both the P&C and Life insurance sectors, for most attributes • Domain 6 – e Waste management – has high ratings for the reuse and recycle attributes for both the P&C and Life insurance sectors, but low ratings for disposal and RF emissions
Table 35. Model attributes with highest and lowest maturity for ***insurance sector***. This table lists the model attributes with the highest and lowest maturity scores attributes for the insurance sector.	• The highest maturity ratings occur for some of Domain 4 and 6 model attributes such as travel, reuse and recycle.
Table 36. Model attributes with highest and lowest maturity for ***P&C insurance sector***. This table lists the model attributes with the highest and lowest maturity scores attributes for the P&C insurance sector.	• The highest maturity ratings occur for some of Domain 4 and 6 model attributes such as travel, reuse and recycle. • The lower ratings occur for Domain 1 and 2.
Table 37. Model attributes with highest and lowest maturity for ***Life insurance sector***. This table lists the model attributes with the highest and lowest maturity scores attributes for the Life insurance sector.	• The higher ratings occur for model attributes in Domain 1, 4 and 6. • Lower ratings for attributes in Domain 2 and 6.

5.2.3. Analysis of maturity levels related to the IT life cycle

Figure 7 shows the results from the ICT life cycle perspective and can be summarised as follows:

- Policy/ strategy development, aligned with Domain 1, have lower Green ICT maturity for the insurance sector and P&C (respondents 1-4), but is highest for the Life insurance sector (respondents 5-6)
- Plan/ procure, aligned with Domain 2, have the lowest maturity for all insurance
- Use, aligned with Domain 3, 4 and 5, have the highest maturity for Life sector (Respondent 5-6), the P&C results (Respondents 1-4) are low maturity
- Dispose (waste management), aligned with Domain 6, is highest maturity for P&C (respondents 1-4) and high for Life (Respondents 5-6) and highest average

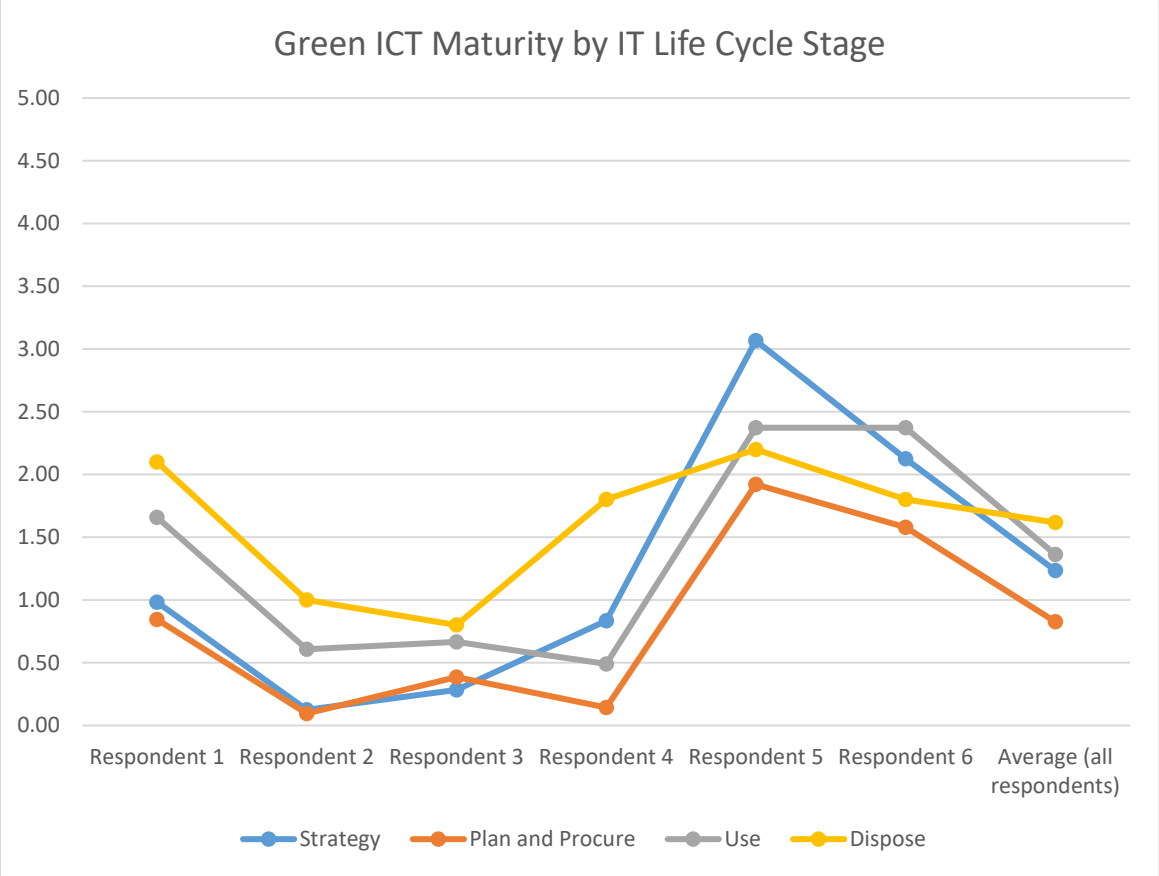


Figure 7. Green ICT Maturity related to IT Life Cycle

5.2.4. Analysis of maturity levels related to the direct, indirect, and systemic effects

Figure 8 shows the results for the Environmental Effects of ICT (direct, indirect, and systemic effects). The maturity of indirect effects is slightly higher than the maturity of direct effects. Systemic effects have the lowest maturity. For all three effects the scores for the Life sector (Respondents 5-6) are higher than the P&C sector (respondents 1-4).

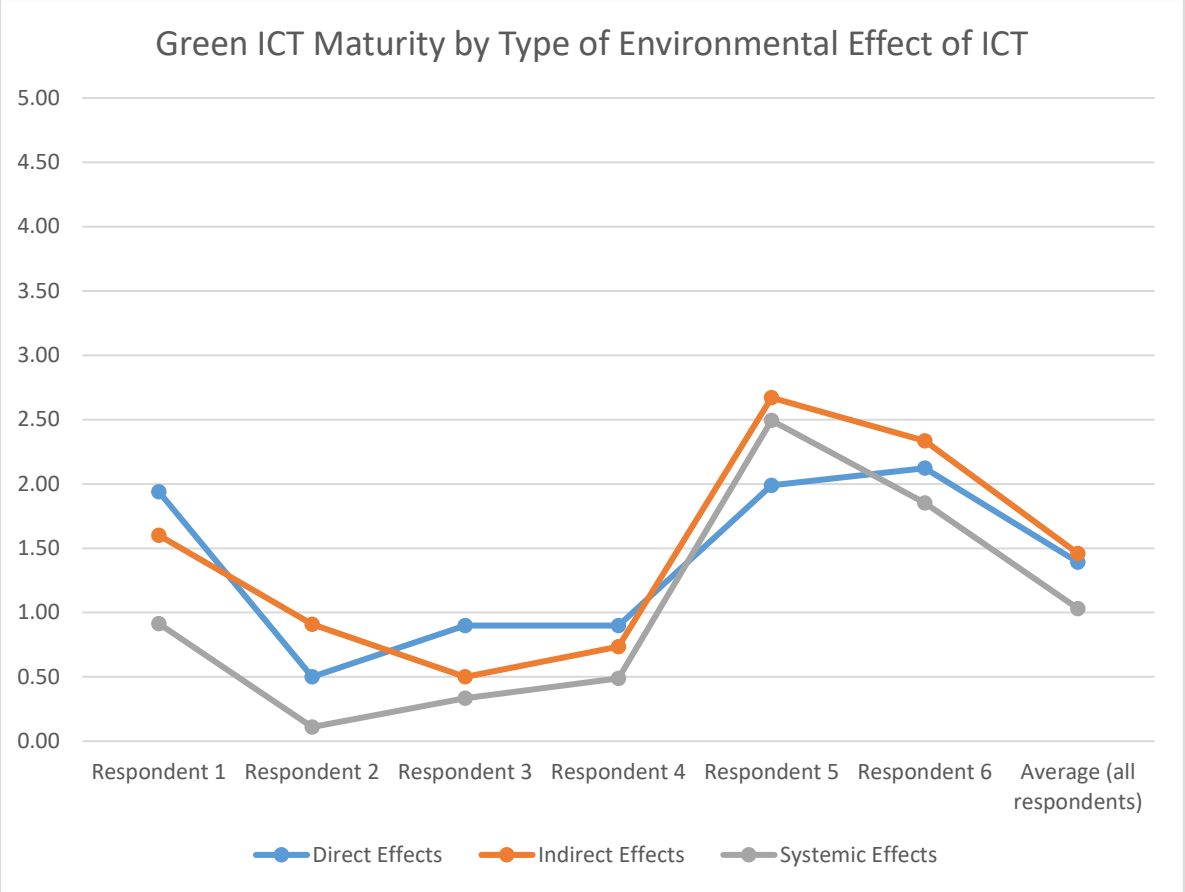


Figure 8. Green ICT Maturity by Environmental Effect of ICT

5.2.5. Analysis by P&C and Life insurance sector

Figure 9 and 10 show the maturity levels, averaged for all respondents, by domain and for the insurance sector and the P&C and Life insurance subsectors. Figure 9 provides this in a line graph format, Figure 10 is in radar format. The graphs show that the Life Insurance maturity levels are above the insurance sector average and P&C sector for all domains. The graphs show that these organisations must improve in all Domains to reach a maturity level 3, with P&C companies being significantly higher challenge to get to this level 3.

5.2.6. Analysis Summary

In conclusion, Domain 4 is the most mature across all respondents and for P&C and Life sector but on average below the maturity level 3. The Life insurance sectors' maturity ratings for all domains are higher than the P&C sector but below the maturity level 3. Insurance organisations must significantly improve in all Domains to reach a maturity level 3, with P&C companies having a bigger challenge to achieve this level 3.

5.3. Results for Questions E1-E4

Table 20 and 21 summarise the key points and results from the interviews with the respondents. The details are in Appendix 11. In Table 20, a 'Yes' means that the respondent had a positive response to the question and a 'No' means that the respondent had a negative response to the interview question. Respondents had suggestions for changes to the topics related to questions - these key points are included in table 21. Transcripts of the interviews were completed and shared with the thesis supervisor.

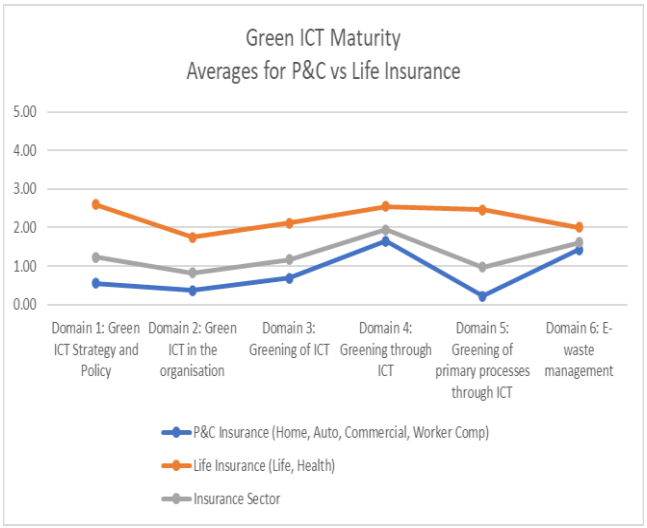


Figure 9. Green ICT Maturity Results by Domain and Type of Insurance – P&C vs Life – Line Chart

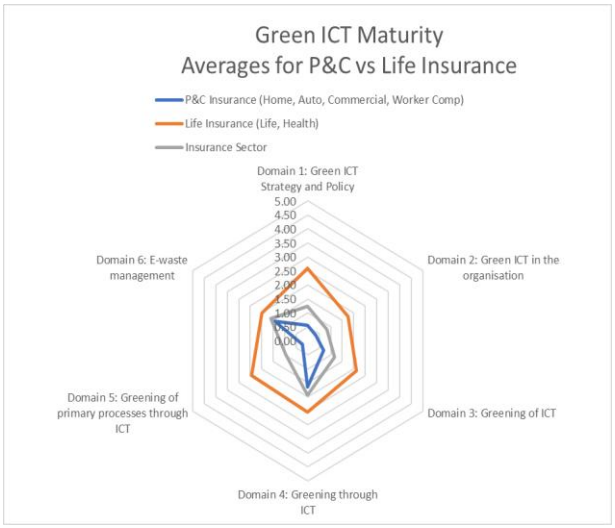


Figure 10. Green ICT Maturity Results by Domain and Type of Insurance, P&C-Life, Radar Chart

Table 20. *Summary of Interview Responses from Six Respondents*

	Respondent						
Interview Questions	1	2	3	4	5	6	Overall
Insurance type (P = P&C, L = Life insurance)	P	P	P	P	L	L	4P + 2 L
Respondent validated interview report (Y = Yes and N = No)	Y	Y	N	Y	Y	Y	5Y + 1N
Size of organisation[8]	>C$ 250M	>C$ 1B	>C$ 1B	>C$ 250M	>C$ 1B	>C$ 1B	
Respondent from IT or business (B) areas	IT	IT	IT	B	B	IT	4IT + 2B
E1.1. Clear measurement tool?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E1.2. Time to complete tool (in minutes)	40	45	30	40	30	50	30-50
E1.3. Tool easy to use?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E1.4. Tool effective to assess maturity?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E2.1. Domains sufficient?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E2.2. Attribute definitions clear and complete?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E2.3. 5 maturity levels appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E2.4. Weighting of domain and attribute	Equal	Equal	Equal	Equal	Equal	Equal	Equal
E2.5. Model current?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E2.6. Other factors why model is (not) appropriate for use in insurance	1	2	3	4	5	6	7
E3.1 Clear and complete picture of the Green ICT maturity?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E3.2 Model provide insights in maturity?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E4.1 Results clear?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E4.2 Results imply or trigger actions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E4.3 Results highlight or imply areas for improvement?	No	Yes	Yes	Yes	Yes	Yes	Yes

Notes for Table 20

[1] Model will not work for independent brokers - green not important to them. Measurement tool can become insurance's benchmark tool. Green ICT maturity will become critical for the insurance sector over next 10 years.

[2] No other factors. Model can apply to any industry.

[3] It is clear on who owns what in this and each domain. Cherry-picking (several items in each domain or just one domain) will not work. You will leave a whole lot of opportunity if you do not action the whole model
[4] As a business user, do I care to be green - with cloud SaaS it's the solution and $$ that count, not if it is green - question is do externalities become part of an organisation's green footprint.
[5] Insurance sector has an opportunity to be very green - it deals in data. Just need to watch out for doing things in a way that are not green.
[6] Younger people value companies that are greener or work on becoming greener. Will get frustrated if not green. Some financial services legislation works against becoming greener
[7] Green ICT maturity is impacted by external parties such as brokers and independent sales agents, and clients, who may not be able or willing to participate in green initiatives or processes. Younger people will have an expectation to work with insurance companies that actively work on becoming greener through ICT. Some financial services legislation works against becoming greener
[8] Data on the size of company were obtained from the public website for the Office of the Superintendent of Financial Institutions (https://www.osfi-bsif.gc.ca/, under the Financial institutions tab).

Upon review of the interview responses matrix (Table 20), the key points from the interviews (Appendix 11), the GIMMi measurement results summary (section 5.2) and the interview transcripts (not included in this thesis), Table 21 confirms the respondents answered the empirical questions and suggested the following changes to the GIMMi and measurement tool:

Table 21. *Six Respondents' Answers to Empirical Questions E1-E4 and Respondents' Proposed Changes*

Empirical questions	**Respondents confirmed that (as documented in Table 20 and Appendix 11) t**	**Proposed changes to the GIMMI and measurement tool (as documented in Table 20 and Appendix 11)**
E1. Is an insurance Green ICT maturity model effective in measuring Green ICT maturity in the insurance sector?	• the GIMMI measurement tool is clear on the aspects of Green ICT maturity was being measured (all respondents) • they were able to complete the GIMMi measurement tool in under 1 hour (all respondents) • the measurement tool easy to use and is it inviting to fill out (all respondents) • the GIMMI measurement tool is effective to assess green ICT maturity in your organisation (all respondents)	• Make it easier to use by using colours across tool and model (respondent 3); make it web-based, online tools will improve the ease of use of the tool (respondent 1 and 6); provide context for answers through notes in tool (Respondent 4 and 6) • The tool and model need to be clear on if it relates to IT or to the organisation for each attribute and domain (Respondent 3 and 4). • Provide better and clear context for measurement, model, and tool - delineate domains clearly (Respondent 1, 3, 4 and 5)
E2. Does the proposed insurance Green ICT maturity model need to be changed to measure maturity?	• the presented domains are sufficient (all respondents) • the attribute definitions are clear and complete (all respondents) • use of 5 maturity levels is appropriate to quantify the attributes (all respondents) • domains and attributes need to be equally weighted against the other domains and attributes (all respondents) • the model is current (all respondents) • there are other factors why the proposed model is (not) appropriate for use in the insurance sector (all respondents)	• Labelling/ descriptions needs to be improved (Respondent 1 and 3) • Domain 1: Areas for clarification include distinguishing social responsibility and green/ environmental; incorporating rethinking of purpose and posture of the company to become more sustainable; addressing legislation and compliance factors (All respondents) • Domain 2: The word 'manufacture' is not used for insurance products and services (Respondents 1, 3 and 4). • Domain 3: Technology items can be combined (Respondent 3, 5 and 6) • Domain 4: Facilities management (buildings, heating systems) can be added or separated from the IT related items (Respondent 1, 2, 4, 5, 6) • Domain 5: Attributes need more clarity (All respondents) • Domain 6: Address wording issues (Respondent 1, 4, 5 and 6)
E3. Does an insurance Green ICT	• the model provides a clear and complete picture of the Green ICT	• Suggestions for change are digital platforms/ channel management, combining technical items

Empirical questions	Respondents confirmed that (as documented in Table 20 and Appendix 11) t	Proposed changes to the GIMMI and measurement tool (as documented in Table 20 and Appendix 11)
maturity model provide impacts and insights in (lack of) the maturity of the organisation?	maturity of the organisation (all respondents) • the model provides insights in the organisation's Green ICT maturity (all respondents)	in domain 3, adding finance, HR, facilities (Respondent 3, 5, 6). • In general, the model is current but need to be enhanced with Cloud, digital transformation, AI, carbon offsets, more modern and insurance appropriate terminology. Model is good for 5 years and will need revamping after that (Respondent 1, 2, 4, 5, 6).
E4. Can the maturity model results help define actions and improvements for Green ICT?	• the results from the GIMMI measurements are clear and complete (all respondents) • the results imply or trigger actions to question maturity levels, do additional research and/or help address improvement of maturity levels (all respondents) • the results highlight or imply areas for improvement to improve maturity levels (all respondents except respondent 1)	• Results (radar graph) are clear but limited: highlight the obvious, more perspectives required such as by domain, pie chart (what is left). Useful to put the results in context for example by comparing to other organisations or comparing to insights from other companies. Also, this measurement needs to be done every one or two years to show progress (all respondents) • Results imply actions but triggering of actions depends on the intent of senior management, alignment with strategy and public image (Respondent 2 and 4). • Areas of improvement are not clearly laid out in the model, but the model can be helpful in determining opportunities for improvement (Respondent 1, 2, 3, 5, 6).

6. Discussion, Conclusions and Recommendations

The main research question is '*Which Green ICT maturity framework can measure, evaluate, and improve the environmental impacts of ICT in the insurance sector?'.* The literature and empirical research results and the scientific approach documented in the previous sections encompass the materials to discuss and reflect on the results and from which conclusions can be drawn, an updated Green ICT model can be proposed and recommendations can be made. Table 12 in Section 3.4 presented the empirical questions to be discussed in 6.1 and for conclusions in 6.2.

6.1. Discussion

E0. Who are representative respondents?

The selection of respondents turned out to be time intensive and difficult. The intent was to interview 5-7 respondents from one organisation – but the 4 executives approached replied that their people were too busy and/or they were not interested in Green ICT maturity. The researcher is not sure if contacting of the organisations earlier, and/or more time to respond, and/or contacting more executives, would have led to one organisation being able to participate with a group of 5-7 respondents. The researcher was able to get 6 participants from 5 Canadian insurance organisations: 2 from Auto and Home insurance, 1 from Workers Compensation, 1 from Commercial insurance and 2 from Life insurance companies. Each of the respondents spent about 2 to 2.5 hours on reading the materials, completing the measurement tool, and participating in the interview. Since the model has a lot of detail (6 domains, 40 attributes, 80+ self-measurement questions), this is not a lot of time. The time for the interview and to discuss was about 1 hour. The researcher and respondents had good discussions and valuable feedback was provided on the research questions. However, more time would have allowed for more discussion on the measurement results and how to address, in more detail, the changes proposed by the proponents.

E1. Is an insurance Green ICT Maturity Model effective for measuring maturity?

The measurement tool was provided in a Microsoft Excel spreadsheet – all respondents were comfortable working with the spreadsheet. All respondents identified challenges with how some questions were phrased: some questions were stated in a negative form so they needed to answer on a reverse scale, phrasing of some questions was unclear due to grammar errors or choice of words. In some cases, the scope of questions was not clear: was it related to IT only or the whole organisation? Respondents commented on the need to provide more clarity on the context and scope of the measurement and each domain and the need to clearly delineate them. Most respondents suggested the use of a web-based measurement tool which can be easier to use and a more intuitive way of responding to measurement questions. This includes setting of contexts, delineation and keeping the scoring legend on the screen. One respondent had a challenge with the measurement topics being in question format as opposed to statements. This was not an issue or discussion point with the other respondents. The researcher will have to investigate what the best practices are for questions versus statements in measurements. Some of the respondents mentioned having to flip back and forth. Using a more intuitive web-based measurement tool would help reduce this. Addition of the colour coding for the measurement tool and the model would make the tool more user friendly. The researcher would support this.

Respondents see value in doing this self-measurement with follow-up interviews on an annual basis, so progress can be measured with the same measurement tool. With multiple organisations participating, respondents felt it would be of value to benchmark and/or compare their maturity levels by domain and attribute with other organisations.

The radar graph in the results tab of the spreadsheet, showing a summary result by domain (Figure 10), was clear and, for some respondents, useful. In general, it was of limited use for all respondents. The radar graph highlights the obvious that most organisations are weak in all domains. Respondents suggested that more perspectives are required:

- radar graphs by domain,
- graphs highlighting domains and attributes for improvement, priority, and/or action
- pie charts showing what and how much is remaining for improvement,
- progress from one measurement year to the next year, and,
- comparison of results and insights with other organisations or to a national average.

Most respondents agreed that the measurement tool was good at providing a 'quick' assessment of their organisation's Green ICT maturity and would provide a clear maturity indicator for all domains. Some respondents felt the measurement tool was too detailed in some domains, specifically Domain 5. The researcher's discussion with the respondents led to the option of having two measurement tools:

- one quick measurement tool such as the one they completed, to be completed in full by multiple people in the organisation. This tool would have questions at the domain and attribute level
- one with more detailed assessments and questions, for each domain, with questions going to the sub-attribute level, with experts of these domains completing those parts of the measurement tool.

E2. Does the proposed insurance Green ICT Maturity Model need to be changed?

Respondents were pleased with the model. It is complete, clear, and comprehensive. Suggestions were made to improve wording of some labels and descriptions, to clarify the scope and intent of several attributes, to enhance several attributes, and to delete the sub-attributes. The respondents confirmed that the model is current and will be good for 5 years and will need revamping after that. It needs to be enhanced with current and future IT trends and technologies: cloud technologies (SaaS, IaaS, etc.), digital transformation, IoT and AI artificial intelligence.

Terminology in IT and insurance has been evolving and the model should accommodate this over time. One respondent asked how carbon offsets will fit into the model. A carbon offset is a credit for emissions reductions given to one party that can be sold to another party to compensate for its emissions. Carbon offsets are typically measured in tonnes of CO2-equivalents and are bought and sold through international brokers, online retailers and trading platforms (David Suzuki Foundation, 2020). Additional research will have to be done on carbon offsets and if it fits with Attribute 6.6 Green House Gas emission management or Attribute 2.5 Green Energy Source.

Two respondents asked enhancing the use and description of the 1st, 2nd, and 3rd order and the life cycle. They also asked to elaborate on how these concepts enhance the value of the model. Some of the descriptions from section 3.3.6

The respondents agreed that a 0-5 maturity levels aligned with CMMI were appropriate. At the start of this thesis, during the model and measurement tool design, the researcher developed a maturity level description for each level for each attribute. However, the researcher decided to simplify the scoring levels (see Table 11 and section 3.3.6) with the same descriptions to be used for all attributes. When discussing this approach with the respondents, they all agreed that the simplified approach was preferred, saved them time, and made the process easier and more understandable.

In Domain 1, the words social responsibility, green and environmental are used with the intent to have the same meaning. One respondent pointed out this was incorrect; the others did not have an issue with these terms being used intermittently. The researcher defined the terms in Section 1 and agrees that use of the correct terms in the context of the model and measurement tool is required and this clarity needs to be implemented. Domain 1 includes policy, strategy, governance, and culture, as it is, with or without specific sustainability or green statements. Several respondents suggested to specifically incorporate the rethinking of the purpose and posture of the company to become more sustainable, to have 'green' products and services, and to include and enforce green practices with their suppliers, partners and clients. For Domain 1, respondents were not aware of any specific legislation and compliance factors for the Canadian insurance industry.

In Domain 2, the word 'manufacture' is used but this is not a commonly used word in insurance for the development and rollout of insurance products and services. It should be replaced with 'develop'. For Domain 3, most respondents felt that the technology attributes Computing, Network, and Storage Infrastructure can be combined into one Infrastructure attribute. Facilities management could be added to Domain 4. Domain 2 has energy savings and Domain 4 has space savings. Two respondents felt that the term Facilities management has a larger scope and includes buildings, office space, heating systems, other monitoring systems, that are not really part of the scope of IT related items.

For Domain 5, most respondents could not envision how ICT could help with these business processes becoming 'greener' and more mature. Technologies such as AI, cloud and digitisation of business processes are some of the technologies to support Domain 5 improvement activities. Digital platforms and channel management may be an item to be added to Domain 5 as part of digital transformation programs. Even though Domain 5 focuses on primary processes, several respondents questioned if some of the support processes such as finance, accounting and HR should be shown in Domain 5. The researcher provided questions at the sub-attribute level for Domain 5. Several respondents felt there was too much detail in Domain 5. The researcher agrees that the questions should have been kept at the attribute level for this thesis. For Domain 6, reuse and recycle were well known by all respondents but disposal and Radiation emissions were attributes they had not specifically considered.

All respondents commented that going through the measurement and interview heightened their awareness of Green ICT maturity and were surprised and pleased to see the broad scope of the various domains and attributes that are part of the model and the self-measurement.

E3. Does an insurance Green ICT maturity model provide impacts and insights?

Since the measurements showed low maturity levels, the respondents said that the impacts and insights of the lack of maturity of the casus organisations were obvious. For those attributes that were more mature (4.1 travel, 4.4 paper and 6.2 recycle), the respondents were clear that the organisations had significant impact with the insight that the actions need to be continued or increased. For most of the other attributes, the respondents were clear that there are no impacts or insights yet. Results from measurements like the one done by the respondents may trigger action from executives to see the lack of maturity and the impact of this lack on the environment.

E4. Can the maturity model results help define actions and improvements for Green ICT?

Since the measurements showed low maturity levels, many actions for improvement were implied. Respondents said the results would not trigger action at the respondents' organisations. The organisations currently do not have the intent to improve Green ICT maturity. A better public image will not be accomplished through Green ICT maturity. Executive call-to-action and executive buy-in would be required to fund projects to improve the maturity of the organisation. All

respondents agreed that the model and a low rating for a domain and/or attribute would help to easily identify areas for improvement, but the model and the measurement tool do not articulate these areas or specific actions for improvement. An action project plan, with scope, timing, resources, and business case, would need to be proposed to the executive team.

E5. What is the maturity of the case organisations?

The respondents were not surprised with their maturity scores for most domains in their measurements, with Domain 4 and 6 being the highest and the other domains with low maturity. Some respondents knew that their organisation was immature with respect to Green ICT and the results of their measurement confirmed that and/or pointed that out as obvious. All respondents knew therefore that actions could be determined for all domains and most attributes, just by looking at the low scoring attributes. If the respondents' organisations had been more mature, specific actions for specific attributes could have been identified.

Figures 6 to 10 show the maturity levels of the respondents' organisations and compares the results across companies. Once all measurement results were tallied, the figures were generated quickly. These figures were not shared with the respondents due to timing of the data analysis which was after the interviews were completed. Respondents were interested in seeing these graphs and this was mentioned during the interviews. A discussion of these graphs with the respondents would have been an interesting follow up interview: to see their reaction how their responses compared to the others and to see the difference between P&C and Life insurance results.

6.2. Conclusions

E0. Who are representative respondents?

The respondents were not experts for all domains, and some had no knowledge of some domains (Table 18 and Figure 5). This helped speed up their time spent on the measurement but if the research had allowed for more time, the respondents could have involved domain or attributes experts in their organisation to assess these domains. This would have led to less 'low measurement scores' in the results and overall to more representative results.

E1. Is an insurance Green ICT Maturity Model effective in measuring Green ICT maturity?

The main research question was '*Which Green ICT maturity framework can measure, evaluate and improve the environmental impacts of ICT in the insurance sector?'.* To derive a Green ICT maturity model for the insurance sector, nine models were analysed in Section 3. The resulting GIMMi model is shown in section 3.3.6, Figure 4, and Table 10. The researcher concludes that based on the interview results it can be confirmed that the GIMMi model and measurement tool are effective and relevant. The results also confirm that the measurement tool is relevant and measures maturity for insurance companies.

E2. Does the proposed insurance Green ICT Maturity Model need to be changed?

Some modifications and clarifications are required. The scope of proposed changes are clarifications of domains and attributes. The changes are easily understood and unambiguous and have therefore been applied to the model and tool. Appendix 13 shows the updated GIMMi model and Appendix 14 shows the updated measurement tool, both with changes highlighted in yellow.

E3. Does an insurance Green ICT maturity model provide impacts and insights?

The research was not conclusive on this question due to the low maturity levels of the casus organisations. The researcher concludes that the model can be improved to provide impacts and insights in the maturity of organisation.

E4. Can the maturity model results help define actions and improvements for Green ICT?

The GIMMi model and measurement tool can be valuable tools for the insurance sector to assess Green ICT maturity of insurance companies. The measurement results can be used to identify areas for improvement and to communicate internally and externally about the organisation's state of maturity and actions to improve. Over time, by doing the measurements and interviews on a regular basis, measurable progress can be shown. With multiple organisations in the insurance sector participating in these measurements, comparison and benchmarking of domains' maturity and proposed action items can be shown. Co-operation between companies could be considered.

E5. What is the maturity of the case organisations?

The current level of Green ICT maturity is low in the insurance sector. This provides each organisation with the opportunity to make significant improvements and can start with the low hanging fruit, items that can be quickly addressed with minimal effort.

6.3. Recommendations for Practice

The insurance sector can start using this model and measurement tool to assess the maturity of Green ICT. From the interviews and measurements, it became clear that there is low awareness of the domains and attributes for Green ICT maturity and in addition, that maturity is low too across all domains. Green ICT maturity is not a business priority for insurance organisations. Their priority is making money and saving costs. Any projects and actions for Sustainability through ICT will need a solid business case to get successful consideration by executive teams. With executive buy-in, the insurance organisations can develop (shared) clear policies and strategies, incorporate 'green assessment and improvements' in their project and systems methodologies, and have a purpose and intent to make a difference. As a result, they will reduce the insurance sector's carbon footprint. With multiple green projects over time, 'green thinking and actioning' can become part of every business and ICT process in the insurance sector. The model and the measurement tool then can become a valued set of tools for improving an organisation's Green ICT maturity.

6.4. Recommendations for Further Research

This model and the GIMMi measurement tool were used and reviewed by 6 respondents. Further empirical research should involve domain experts with more experts in the 5 organisations and other insurance organisations. This research is required for validation, completeness, and relevance, especially with insurance companies that have achieved or target to achieve a higher level of maturity. As more feedback is received, the model and tool can be further fine-tuned. In preparation of doing this further research, a web-based measurement tool should be implemented. Colour coding should be applied to delineate the domains. Further research is:

- the development of a more detailed measurement tool for all domains, at the sub-attribute level
- required to determine which results summaries are most effective in presenting the results of measurements, by year, year-over-year, and compared to other organisations and an industry average
- for the use of simple maturity definitions (Table 11) versus full maturity descriptions by attribute by maturity level, and the impact on the maturity levels for the participating organisations
- on carbon offsets and if it fits with Attribute 6.6 Green House Gas emission management or Attribute 2.5 Green Energy Source
- which maturity levels, by domain and attribute, provide different types of insights for the organisation, for business processes and ICT, and which types of actions or specific actions are recommended to improve the maturity levels of domains, attributes and (ICT and business) processes

- how an insurance company can develop or incorporate green ICT practices for new (green) products and services
- the state of current and future national and international legislation for Green (ICT) in the insurance sector to assess which countries are lagging and leading with Green legislations and to determine the legislation's (potential) impact on the insurance sector's Green ICT maturity levels.

6.5. Reflection

The research process followed for this thesis has given the researcher a broad and focused set of research skills and experience. At times, the discipline and time required to complete research, specifically the literature searches and reviews and the interviews, were challenging. The researcher was pleased and encouraged by the energy and support from the respondents and students and staff at the Open Universiteit. The researcher is happy with this report, as the developed Green ICT Maturity Model and measurement tool for the insurance sector were supported and validated by the respondents, with little change, and a scientific approach was used.

Even though the respondents confirmed that the GIMMi model and measurement tool are relevant, the scope of the empirical research was limited. There was not enough time available to discuss in more detail with the respondents. More respondents and organisations are required to validate and fine-tune the model. The enhancements made to the SURF model, resulting in the GIMMi model, could be used in other sectors as they are not specific to the insurance sector (except for the insurance primary processes attributes). The model and measurement tool will continue to need modernisation with current and future developments and trends in the ICT, sustainability, Green ICT maturity models, legislation, and the insurance sector. The respondents already raised developments related to cloud computing, AI, and digitisation of business processes. The researcher completed the interviews in 1 hour. Upon review of the interview transcripts, it was obvious that not all questions were given sufficient time and discussion. The researcher was not able to consistently ask sufficient and relevant follow-up questions. With the knowledge of the all interview and measurement results, a follow-up interview would have been interesting to get further feedback and insights from the respondents and tweak the conclusions from section 6.2.

Validity

Construct validity

From the researcher's perspective, the construct validity of the research can be challenged. During the empirical research, a well-defined procedure was followed to gather data, through a semi-structured interview (see section 4.1, 4.2 and 4.3) and a self-measurement tool. Actions undertaken to promote good construct validity include established chains of evidence, the respondents are identifiable, the interviews were taped, and the respondents were asked to correct the transcripts of the interviews (which 5 of the 6 respondent did). Review of draft versions of the report were completed by the professors guiding this thesis. Construct validity was weakened: one respondent did not validate their transcript and the respondents did not review drafts of the thesis reports and findings. Also, as mentioned earlier, none of the respondents were experts in all the domains. It would have been more appropriate to have experts assess the maturity of the domains in the insurance companies. As the empirical research was completed with six respondents from 5 different organisation, it would have been better to have had multiple people from the same organisation. The respondents were selected by the researcher based on past working relationships. Even though the topic of research was never part of these relationships, the chance for bias in interpreting results and feedback was clearly present.

Internal validity

From the researcher's perspective, the internal validity of the research can be challenged. The first part of this thesis was completed using a scientific approach, which included a literature study of scientific research by multiple researchers using definitions, comparisons, and reviews of Green ICT maturity models (sections 3 and 4). One of these models, the SURF GIMM model, is used as a base for the proposed model, has been validated in the education sector in the Netherlands (Hankel et al., 2014; Lautenschutz et al., 2018). The empirical research data were collected from semi structured interviews and a self-measurement tool. The respondents were selected based on criteria (see section 4.2) but did not represent the required knowledge and skills to make a relevant contribution to all of the domains in the proposed model (table 8 and figure 5). The pre-read material was sent one week before the interview, which gave the respondent an opportunity to think about his/her responses ahead of time. The respondents were provided with definitions of all terms to ensure that each interview used the same definitions of terminology. The respondents did express a lack of clarity around some of the model's attributes and the delineation between the domains. The interview results did lead to an improvement of the model and the measurement tool. The performance of the respondent or the respondent's department was not evaluated with respect to Green ICT. Even though each respondent had his/her own (strong) opinions about Green ICT, the focus was kept on the model and away from performance, using common terminology, and helped to keep the respondent's bias to a minimum. Follow-up questions were used during the interviews to clarify statements when an opinion was expressed.

External validity

From the researcher's perspective, the external validity of the research can be challenged. Due to the small number of respondents from multiple organisations, external validity is challenged as the research results may not be generalisable. The respondents' interviews and measurement results confirmed that their organisations may not be representative of the Canadian insurance sector. The respondents were selected based on specific criteria to ensure broad and varied expertise from the organisation, which was not fully accomplished. To strengthen external validity, the research should be expanded with other insurance companies and domain experts.

Reliability

From the researcher's perspective, the reliability of the research was sound. Interviews were recorded and each respondent was assigned a number. Five of the six respondents approved the interview summary. The clearly documented scientific approach, the description and steps for the research and results, allow for this research to be reproduced by a different researcher.

Ethics

From the researcher's perspective, there were no ethical challenges during this research. Only the researcher and respondent were present during the interview. All recordings will be deleted on April 20, 2020. Data was processed anonymously and confidentially. The research, interviews and self-measurements were completed in an ethically responsible manner: anonymity, same questions, documented results tracking, no (monetary) incentives to influence results, no hidden motives for the interviews (performance review), and no external (executive) influence on results, consent to participate by the respondents, and voluntary participation.

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Appendix 1. Descriptions of Primary Insurance Processes

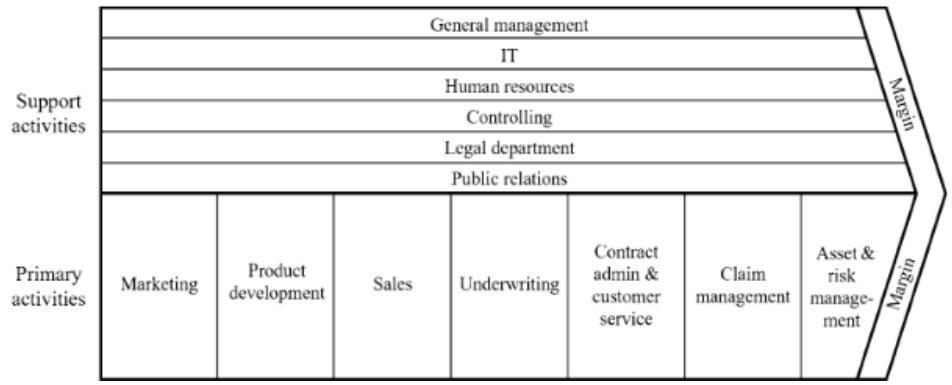

Figure 11. Primary Processes for Insurance

The primary activities employ the most people and are the most technology-intensive activities:

- During the Marketing process, market and customer research is completed, target groups are analysed, pricing strategy are developed, advertisement and communication strategies are designed, and events are managed
- During the Product Development process, products and services are developed, products are priced, legal requirements are addressed and products are launched
- During the sales process, insurance is sold and contracted, either directly or indirectly through brokers. Paper, web, and app-based tools are used to provide multiple quotes from multiple insurers, with specific terms, conditions, and costs, so the client can make an informed decision to purchase the insurance.
- During the underwriting process, insurance contracts are developed with specific terms, conditions and costs based on the client's insurance and claims history.
- During the contract administration and customer service process, the client can make changes to the terms and conditions, pay bills, make (address) changes, cancel or renew contracts, and ask questions and clarifications.
- During the claim management process, the client requests support and compensation for an incident (loss, death, damage) incurred during the life of the contract. The insurer will assess the incident, the impact of the incident on the insured(s) and execute next steps to support the insured(s) such as providing temporary accommodations and vehicles, assessments by doctors, hospital visits and drug payments, and eventually the final payment for the claim (like the replacement of a home or car)
- During the Asset and Risk management process, assets are allocated, asset liabilities are managed, and all risks are analysed and mitigated/managed.

Appendix 2. Literature Provided as a Starting Point

Table 22. *Starting List of Articles for this Thesis*

Related to Green ICT	Related to Maturity Model	Related to Green ICT Maturity Model	Reference	Title	Year
X			(Counotte-Potman, 2010)	Duurzaamheid van ict-intensieve organisaties	2010
X			(Curley et al., 2016)	Green ICT	2016
X			(Khor, Thurasamy, Ahmad, Halim, & May-Chiun, 2015)	Bridging the Gap of Green ICT/ IS and Sustainable Consumption	2015
X			(Lennerfors et al., 2015)	ICT and environmental sustainability in a changing society	2015
X			(Molla & Cooper, 2010)	Green ICT readiness: A framework and preliminary proof of concept	2009
X			(Molla et al., 2011)	The Green ICT readiness (G-readiness) of organisations: An exploratory analysis of a construct and instrument	2011
X			(Patón-Romero et al., 2017)	A governance and management framework for Green ICT	2017
X			(Sheridan et al., 2012)	Harnessing Green ICT - Principles and Practices	2012
	X		(Becker et al., 2009)	Developing Maturity Models for IT Management	2009
	X		(Paulk & Curtis, 1993)	Capability Maturity Model, Version 1	1993
	X		(Pöppelbuß & Röglinger, 2011)	What makes a useful maturity model? A framework of general design principles for maturity models and its demonstration in business process management	2011
		X	(Buchalcevova, 2016)	Green ICT Maturity Model for Czech SMEs	2016
		X	(Curry & Donnellan, 2012)	Understanding the Maturity of Sustainable ICT	2012
		X	(Donnellan et al., 2011)	A capability maturity framework for sustainable information and communication technology	2011
		X	(Foogooa et al., 2015)	Green ICT Maturity Models	2015
		X	(Hankel et al., 2014)	A Maturity Model for Green ICT: The case of the SURF Green ICT Maturity Model	2014
		X	(Hankel et al., 2017)	Green ICT Assessment for Organisations	2017
		X	(Hubers, 2019)	Green ICT Maturity Model in the supermarket logistics sector	2019
		X	(Lautenschutz et al., 2018)	A Comparative Analysis of Green ICT Maturity Models	2018
		X	(Molla & Cooper, Vanessa Pittayachawan, 2009)	IT and Eco-sustainability: Developing and Validating a Green ICT Readiness Model	2009
		X	(Park et al., 2012)	Assessing and Managing an Organisation's Green ICT Maturity	2012
		X	(Philipson, 2010)	A Green ICT Framework Understanding and Measuring Green ICT	2010
		X	(Siebes, 2019)	Groene ICT-volwassenheidsmodel voor bancaire sector Green ICT Maturity Model for the Banking Sector	2019
		X	(Sondagh, 2018)	Green ICT within the Semiconductor Industry	2018

Appendix 3. Snowball Research Results for L1-L3

Once decided on a starting set of articles, backward and forward snowballing can start.

- Backward snowballing means using the reference lists to identify new papers to include. Due to time constraints, limited time was spent on backward snowballing - no new articles were identified.
- Forward snowballing refers to identifying new papers based on those papers, citing the paper examined. Once iterations are concluded, it is recommended to research the authors, journals or conferences of the included literature to potentially identify additional papers (Wohlin, 2014). Due to time constraints, limited time was spent on researching authors, journals, and conference – now new articles were identified.

The list of found articles will be scanned for relevance and usability, and if relevant, and added to the list of 'Relevant articles from Literature Search Results' in Appendix 5.

*citations on Google Scholar on November 1, 2019

Table 23. *Snowball Research Searches and Results*

Literature research questions	Sources Used	Reference articles used for snowballing	# of Citations*	Forward Snowballing Results
L1. What is Green ICT?	Google Scholar Open Universiteit Library In addition, specific databases: 1. EBSCO Business source premier	(Counotte-Potman, 2010)	0	
		(Curley et al., 2016)	3	no new articles identified
		(Khor et al., 2015)	27	no new articles identified
		(Lennerfors et al., 2015)	13	no new articles identified
		(Molla & Cooper, 2010)	94	The 2011 updates are already in the literature list
		(Molla et al., 2011)	103	2017 article by Molla, Cooper was added to the list in Appendix 5 (Loeser, Recker, Brocke, Molla, & Zarnekow, 2017)
		(Patón-Romero et al., 2017)	16	a number of articles were found related to Green ICT Governance and Management based on SPICE model, ISO 14000 and ISO 15504 but they were not accessible through the library
		(Sheridan et al., 2012)	97	2017 article by Loeser were added to the list in Appendix 5 (Loeser, Recker, Brocke, et al., 2017)

Literature research questions	Sources Used	Reference articles used for snowballing	# of Citations*	Forward Snowballing Results
L2. What is a maturity model?	Google Scholar Open Universiteit Library In addition, specific databases: EBSCO Business source premier Greenlife EBSCO	(Becker et al., 2009)	694	Refers to Pöppelbuß and Wendler research referenced in other sections
		(Paulk & Curtis, 1993)	2748	Old article and lots has been written on CCM since; did a Green ICT maturity model search on 2748 articles, had 85 hits, did not identify anything new
		(Pöppelbuß & Röglinger, 2011)	255	More recent 2012 article by Pöppelbuß but could not download; Roglinger has done additional papers on maturing maturity models from 2017, but could not download
L3. What are the criteria for a Green ICT maturity model?	Google Scholar Open Universiteit Library In addition, specific databases: EBSCO Business source premier Greenlife EBSCO	(Buchalcevova, 2015)	16	references to Hankel and Paton's newer articles, but no new articles identified
		(Curry & Donnellan, 2012)	38	no new articles identified
		(Donnellan et al., 2011)	125	identified a 2018 article by Hankel – added it to the list in Appendix 5
		(Foogooa et al., 2015)	2	no new articles identified
		(Hankel et al., 2014)	25	no new articles identified
		(Hankel et al., 2017)	5	no new articles identified
		(Hubers, 2019)	0	
		(Lautenschutz et al., 2018)	3	no new articles identified
		(Molla & Cooper, Vanessa Pittayachawan, 2009)	208	no new articles identified
		(Park et al., 2012)	29	no new articles identified
		(Philipson, 2010)	34	identified a Green ICT maturity model article from 2019 by Paton-Romero, but could not access it
		(Siebes, 2019)	0	
		(Sondagh, 2018)	0	

Appendix 4. Literature Building Block Research Queries and Criteria for L3-L6

This appendix provides the literature building blocks research approach details for L3-L6. An effective way to search the literature is to break the topic into different 'building blocks.' The building blocks approach is systematic and works the best in periodical databases. The 'blocks' in a 'building blocks' strategy consist of the key concepts in the search topic. Then:

1. Gather synonyms and related terms to represent each concept and match to available subject headings in databases.
2. Organise the resulting concepts into individual queries.
3. Run the queries and examine results to find relevant items
4. Modify queries to improve your results.
5. Revise and re-run strategy based on observations.
6. Repeat this process until satisfied or further modifications produce no improvements.
7. Keep detailed notes on the literature search, as it will need to be reported.

Noting of search strategies also allows revisiting a topic in the future and confidently replicate the same results, with the addition of those subsequently published on the researches topics (Boren & Moxley, 2015; Saunders et al., 2016).

Table 24. *Building Block Research Queries and Criteria for this Thesis*

Literature research questions	Queries used with Block Building Method	Additional criteria	Sources used
L3. What are the criteria for a Green ICT maturity model?	(green or sustainable or sustainability) AND (IT or ICT or Information technology or technology or software) AND (Maturity or capability) AND (Models or frameworks) (Green ICT or sustainable ICT or green ICT or green information technology) AND (Maturity model or capability model or maturity framework)	• Included: ○ Timeframe: all, past 5 years ○ Content type: all, journal article ○ Peer reviewed ○ Discipline: all, Business, computer science ○ Language: English • Excluded: ○ Newspaper articles ○ Dissertations ○ Books	Google Scholar Open Universiteit Library: advanced search and Business Source Premier (EBSCO)
L4. Which criteria are required to assess a Green ICT maturity model for the insurance sector?	Green ICT and insurance Green ICT and maturity model and insurance	• Included: ○ Timeframe: all, past 5 years ○ Content type: all, journal article ○ Peer reviewed	Google Scholar Open Universiteit Library: advanced search and Business Source Premier (EBSCO)

Literature research questions	Queries used with Block Building Method	Additional criteria	Sources used
L5. From literature, are there suitable Green ICT maturity models for the insurance sector? L6. How to define and describe a relevant Green ICT maturity model for the insurance sector? For answering L5 and L6 there is no additional search method required. The results used for answering L4, as L5 and L6 are extensions of L4.	(green) AND (IT or ICT) AND (insurance or claims) (green) AND (IT or ICT) AND (Maturity) AND (insurance or claims) (green or sustainable or sustainability) AND (IT or ICT or Information technology or technology or software) AND (Maturity or capability) AND (Models or frameworks) AND (insurance or claims) (green or sustainable or sustainability) AND (IT or ICT or Information technology or technology) AND (Maturity or capability) AND (Models or frameworks) AND (design principles or criteria) AND (comparison or evaluation) AND (insurance or claims)	○ Discipline: all, Business, computer science ○ Language: English • Excluded: ○ Newspaper articles ○ Dissertations ○ Books	

Appendix 5. Building Block Search Results

This appendix presents the search results for each research question. When the queries resulted in many hits, the query was modified and / or filters were applied on date (less than 5 years), on review type (peer review) and other filters where required.

The articles found because of the query were scanned, by looking at the title and/or key words and/or the abstract and/or the summary/ conclusions. Articles that were found to be relevant after the scan, were read (completely). Once read, those articles, with content to be to answer the research question(s), were listed in a reference list and some content may be included in the results and conclusions. When issues occurred with certain queries (for example, search terms do not lead to expected results), then the approach was changed, and queries were added or modified.

Table 25. *Building Block Search Results*

Literature Research Question	Query #	Query	Search Criteria	Hits in OU Library	Hits on Google Scholar	Number of Hits Scanned	Number of Articles Found Relevant
L3	1	(green or sustainable or sustainability) AND (IT or ICT or Information technology or technology or software) AND (Maturity or capability) AND (Models or frameworks)	Query date 14 October 2019 Timeframe: All Content: Journal Article only Disciplines: All Language: English Limit to: All Excluded: newspaper articles, book reviews, dissertations	108	16,400	94	6
L3	2	(green or sustainable or sustainability) AND (IT or ICT or Information technology or technology or software) AND (Maturity or capability) AND (Models or frameworks)	Query date 14 October 2019 Timeframe: All Content: Journal Article only Disciplines: All Language: English Limit to: Peer reviewed Excluded: newspaper articles, book reviews, dissertations	94	16,300	94	6
L3	3	(green or sustainable or sustainability) AND (IT or ICT or Information technology or technology or software) AND (Maturity or	Query date 14 October 2019 Timeframe: Last 5 years Content: Journal Article only Disciplines: Business	10	129	139	2

Literature Research Question	Query #	Query	Search Criteria	Hits in OU Library	Hits on Google Scholar	Number of Hits Scanned	Number of Articles Found Relevant
		capability) AND (Models or frameworks)	Language: English Limit to: Peer reviewed Excluded: newspaper articles, book reviews, dissertations				
L3	4	(Green ICT or sustainable IT or green ICT or green information technology) AND (Maturity model or capability model or maturity framework)	Query date 18 October 2019 Timeframe: All Content: Journal Article only Disciplines: All Language: English Limit to: Peer Reviewed Journals Excluded: newspaper articles, book reviews, dissertations	242	17,300	242	2
L3	5	(Green ICT or sustainable IT or green ICT or green information technology) AND (Maturity model or capability model or maturity framework)	Query date 18 October 2019 Timeframe: Last 5 years Content: Journal Article only Disciplines: Business, Computer Science Language: English Limit to: Peer Reviewed Journals Excluded: newspaper articles, book reviews, dissertations Expanded: Yes	43	243	243	2
L4, L5, L6	1	Green ICT AND insurance	Query date 18 October 2019 Timeframe: Last 5 years Content: Journal Article Disciplines: Business, Computer Science, Ecology, Environmental Sciences, chemistry, engineering Language: English Limit to: Peer Reviewed Journals Excluded: newspaper articles, book reviews, dissertations Expanded: Yes	137	87,500	137	2
L4, L5, L6	2	Maturity model AND criteria AND Green ICT	Query date 18 October 2019 Timeframe: Last 5 years	30266	246,000	50	1

Literature Research Question	Query #	Query	Search Criteria	Hits in OU Library	Hits on Google Scholar	Number of Hits Scanned	Number of Articles Found Relevant
			Content: Journal Article Disciplines: Business, Computer Science, Ecology, Environmental Sciences, chemistry, engineering Language: English Limit to: Peer Reviewed Journals Excluded: newspaper articles, book reviews, dissertations Expanded: Yes				
L4, L5, L6	3	Green ICT AND maturity model AND insurance	Query date 1 November 2019 Timeframe: Last 5 years Content: Journal Article Disciplines: Any Discipline Language: English Limit to: Peer Reviewed Journals Excluded: newspaper articles, book reviews, dissertations Expanded: Yes	343	17,200	200	0
L4, L5, L6	4	(green) AND (IT or ICT) AND (insurance or claims)	Query date 18 October 2019 Timeframe: 2000 to 2013 Content: Journal Article Disciplines: Any Discipline Language: English Limit to: Peer Reviewed Journals Excluded: newspaper articles, book reviews, dissertations Expanded: Yes	137	22,400	137	2
L4, L5, L6	5	(green) AND (IT or ICT) AND (Maturity) AND (insurance or claims)	Query date 18 October 2019 Timeframe: 2000 to 2013 Content: Journal Article Disciplines: Any Discipline Language: English Limit to: Peer Reviewed Journals	80	1,350	80	0

Literature Research Question	Query #	Query	Search Criteria		Hits in OU Library	Hits on Google Scholar	Number of Hits Scanned	Number of Articles Found Relevant
			Excluded: dissertations	newspaper articles, book reviews,				
			Expanded:	Yes				
L4, L5, L6	6	(green or sustainable or sustainability) AND (IT or ICT or Information technology or technology or software) AND (Maturity or capability) AND (Models or frameworks) AND (insurance or claims)	Query date Timeframe: Content: Disciplines: Language: Limit to: Excluded: dissertations Expanded:	14 October 2019 Last 5 years Journal Article Any Discipline English Peer Reviewed Journals newspaper articles, book reviews, Yes	0	1,500	155	4
L4, L5, L6	7	(Green ICT or sustainable IT or green ICT or green information technology) AND (Maturity model or capability model or maturity framework) AND (insurance or claims)	Query date Timeframe: Content: Disciplines: Language: Limit to: Excluded: dissertations Expanded:	14 October 2019 All Journal Article Any Discipline English All newspaper articles, book reviews, Yes	14	5,600	250	1
L4, L5, L6	8	(green or sustainable or sustainability) AND (IT or ICT or Information technology or technology) AND (Maturity or capability) AND (Models or frameworks) AND (design principles or criteria) AND (comparison or evaluation) AND (insurance or claims)	Query date Timeframe: Content: Disciplines: Language: Limit to: Excluded: dissertations Expanded:	29 September 2019 All Journal Article Any Discipline English All newspaper articles, book reviews, Yes	9	1,170	9	0

Appendix 6. Relevant Articles from Literature Search Results

The relevant articles from the literature searches are listed in the table below.

Table 26. *Relevant Articles from Snowball and Building Block Literature Searches*

Source	Nr.	Topic	Citation	Title	Year	Used or Reason Why Not Used
L1	1	Green ICT	(Cooper & Molla, 2017)	Information systems absorptive capacity for environmentally driven IS-enabled transformation	2017	Not used. Does not address maturity or maturity models. It's about capabilities required to address IS enabled environmentally driven change. This may be relevant for future research.
L1	2	Green ICT	(Loeser, Recker, Brocke, et al., 2017)	How IT executives create organisational benefits by translating environmental strategies into Green IS initiatives	2017Not used.	Does not address maturity or maturity models. It is about Green IS strategy and the how the benefits of Green IS initiatives remain poorly understood. This paper clarifies the mechanisms that link organisational beliefs about environmental sustainability to Green IT and Green IS actions undertaken, and the organisational benefits that accrue from these actions. This may be relevant for future research.
L3	3	Green ICT, Maturity	(Hankel et al., 2018)	A Systematic Literature Review of the Factors of Influence on the Environmental Impact of ICT	2018	Yes
L3 query	4	Maturity	(Kusi-Sarpong, Gupta, & Sarkis, 2019)	A supply chain sustainability innovation framework and evaluation methodology	2019	Not used. Does not address maturity or maturity models. Manufacturing sector, not insurance sector.
L4 query	6	Green ICT, Maturity	(Butler, 2011)	Towards a practice-oriented Green IS framework	2011	Yes
L4 query	7	Green ICT, Maturity	(Curry & Donnellan, 2012)	Understanding the maturity of sustainable ICT	2012	Yes
L4 query	8	Green ICT, Maturity	(Donnellan et al., 2011)	A capability Maturity Framework for Sustainable Information and Communication Technology	2012	Yes
L4 query	9	Maturity	(Wendler, 2012)	The maturity of maturity model research: A systematic mapping study	2012	Yes
L4 query	10	Maturity	(Boren & Moxley, 2015)	Systematically reviewing the literature: building the evidence for health care quality	2015	Yes
L4 query	11	Green ICT, Maturity	(Ateetanan & Usanavasin, 2015)	Assessing Green ICT Maturity and Recommendation of Improvement for Government Agencies in Thailand	2015	Not used. It is about Green IT readiness is the Thai government sector. Good article for models used in public sector. Focused on awareness and readiness. Overall limited in comparison to the scope of this research.
L4 query	12	Green ICT	(Khor et al., 2015)	Bridging the Gap of Green ICT/IS and Sustainable Consumption	2015	Not used. Includes overview of Green IT. Does not address maturity or maturity models. Links organisational theories to Green IT (implementation). The article was of limited used for answering the research questions

Source	Nr.	Topic	Citation	Title	Year	Used or Reason Why Not Used
L4 query	13	Green ICT, Maturity	(Radu, 2016)	Determinants of green ICT adoption in organisations: A theoretical perspective	2016	Not used. Covers identifying, analysing, and classifying general and specific determinants of green. The article was of limited used for answering the research questions ICT adoption in organisations. Does not address maturity or maturity models. The article was of limited used for answering the research questions
L4 query	14	Green ICT	(Anthony & Majid, 2016)	Development of a Green ICT Model for Sustainable Enterprise Strategy	2016	Not used. The research seems preliminary and more future research is required to develop the model mentioned in this article.
L4 query	15	Green ICT	(Chandola, 2016)	Digital Transformation and Sustainability: Study and Analysis	2016	Not used. The article focuses on focuses on understanding the link between Digital Transformation and Sustainability. The article is not useful for Green ICT and maturity models.
L4 query	16	Green ICT	(Radu, 2017)	Green cloud computing: A literature survey	2017	Not used. Green cloud computing is explored but is of limited use for this thesis.
L4 query	17	Insurance	(Piljan, Piljan, & Cogoljevic, 2017)	Insurance Sector and Climate Changes in Serbia	2017	Not used. It is about climate change's negative impact on the business of insurance. Does not address maturity or maturity models, or Green IT..
L4 query	18	Green ICT, Maturity	(Stahl et al., 2017)	The responsible research and innovation (RRI) maturity model: Linking theory and practice	2017	Not used. It covers maturity models but not much on Green ICT maturity models.
L4 query	19	Green ICT, Maturity	(Debnath, 2018)	Green IS – information system framework to support environmental sustainability of firms	2018	Not used. By leveraging process-oriented view of organisational functions, we explore how green IS can partner with the business processes (green or red) to encapsulate inherent and desired environmental considerations and bring other IS elements like technologies, systems and users together to interact. It does not address maturity models or Green ICT maturity models.
L4 query	20	Green ICT, Maturity	(Remondino, 2018)	Information technology in healthcare: HHC-MOTES, a novel set of metrics to analyse it sustainability in different areas	2018	Not used. Interesting article on the metrics (KPIs) to analyse IT sustainability. It does not address maturity models or Green ICT maturity models.
L4 query	21	Green ICT	(Breuer, Luedeke-Freund, & Brick, 2018)	Business Model Innovation in the Era of Sustainable Development Goals	2018	Not used. It is about business models. It does not address maturity models or Green ICT maturity models.
L4 query	22	Green ICT, Maturity	(Abraham & Dao, 2019)	A longitudinal exploratory investigation of innovation systems and sustainability maturity using case studies in three industries	2019	Not used. Interesting article about sustainable innovation systems. This may be a future research area for this thesis. It does not address maturity models or Green ICT maturity models.
L4 query	23	Green ICT, Maturity	(Savona & Ciarli, 2019)	Structural Changes and Sustainability: A selected Review of the Empirical Evidence	2019	Not used. The article is focused on emissions and energy intensity. It does not address maturity models or Green ICT maturity models.
L4 query	24	Green ICT, Maturity	(Chilik, Edens, Klush, & Ralph, 2019)	Assessment of Sustainability Maturity Models for Business Transformation	2019	Not used. Interesting article on Strategic Sustainable development. It does not address maturity models or Green ICT maturity models.

Appendix 7. Green ICT Maturity Models

Appendix 7.1. SURF Green ICT Maturity Model (Hankel et al., 2017)

- Researcher: Hankel
- Year: 2017
- Description
    - The SGMM has four domains:
        1. Green ICT in the organisation
        2. Greening of ICT
        3. Greening of operations with ICT
        4. Greening of primary processes with ICT
- Maturity levels:
    - 1 – initial
    - 2 – repeatable
    - 3 – defined
    - 4 – managed
    - 5 - optimise
- Measurement: The SGIMM is designed to give organisations insights into the maturity of Green ICT of the organisation. It is set-up as a self-measurement and enables organisations to have an internal dialogue, to gain agreement on the status quo and to define actions for improvement. By letting several individuals within an organisation score the attributes and discussing theses scores with the participants (average, minimum, maximum scores, etc.), an organisation can identify weak and strong Green ICT aspects. SURF published a manual that guides users through this process of self- measurement together with the model itself.

Appendix 7.2. Green ICT Readiness framework (Molla et al., 2011)

- Researcher: Molla
- Year: 2011
- Description
    - The Green ICT Readiness framework captures the input, transformational and output capabilities that organisations need to nurture in sustainable management of IT. It identifies five components of G-readiness and provides an exploratory framework and a research-ready instrument. The instrument is validated based on data collected from a cross- sectional and cross-country survey of IT managers
    - G-readiness is comprised of the five components of Green ICT Attitude, Policy, Practice, Technology, and Governance:
        1. Green ICT Attitude (ATT) is comprised of items that reflect energy efficiency concerns in managing the IT technical infrastructure. These items tap into managerial attitude and beliefs regarding IT energy utilisation. Because of the nature of current energy sources that use fossil fuel, there is strong correlation between energy use and greenhouse gas emissions. Thus, organisational action on reducing energy consumed by IT infrastructure relates to pollution prevention strategy. However, as sources of energy become cleaner, this association might decline, but the significance and cost of energy consumption remains top of mind. Green ICT attitude captures these dynamics.

2. The Green ICT Policy (POL) items reflect the maturity of policy frameworks involving IT procurement, data centres, and IT's enterprise enablement, that is, policies covering the entire lifecycle of IT. These items tap the product stewardship (4FJ) and clean technologies (4D) strategies in Greening IT and the pollution prevention (4G) strategy in using IT to reduce overall emissions.
3. Green ICT Practice embraces two domain substrata covering the product stewardship and pollution prevention strategies. Subsequently, the first is referred here as procurement (PRA1) with items that indicate an organisation 's action to procure IT in an environmentally friendly way. The second is referred as energy audit and monitoring (PRA2) with items that indicate energy consumption audit and monitoring aspects that relate to pollution prevention.
4. The Technology dimension contains four substrata covering the IT technical infrastructure capability. The first is referred to as IT technical infrastructure (TEC1). The items in this category represent technologies that transform the IT infrastructure into a sustainable platform and tap into the clean technologies' domain. The other three technology domain substrata are named as data centre air flow management (TEC2), data centre cooling systems (TEC3), and power-delivery systems (TEC4). The items in these three categories represent organisational action to improve the energy efficiency of data centres cooling and power delivery platforms and reduce the environmental footprint and tap into the pollution prevention strategy
5. Green ICT Governance has two substrata covering the IT managerial capability. The first is referred here as strategic foresight (GOV1) and the second resource and metrics (GOV2). The items cover management commitment, resource allocation, project management and benefit tracking of Green ICT initiatives designed to prevent pollution, improve product stewardship, and implement clean technologies.

- Maturity levels: Managers (either individually or as a group) can evaluate their performance across the thirty-two items on the scale of 1 (low) to 7 (high). The item scores can be averaged to produce subcomponent values. The subcomponent score can then be averaged to produce a score for the five basic components of G-readiness. Aggregating the five components will yield a G-readiness score out of a maximum of 35. Model does not use a typical concept of maturity, but a concept of readiness
- Measurement: Assessment tool for the five components

Appendix 7.3. Green ICT Framework (Philipson, 2010)

Researcher: Philipson, Connection Research
Year: 2010

The Connection Research-RMIT Green ICT Framework takes a holistic view of Green ICT and sustainability, across the enterprise, and then drills into individual technologies and business best practices. This Framework is used by many organisations to categorise the many aspects of Green ICT. It is also used extensively by Connection Research and its business partners to conduct surveys into Green ICT usage patterns and in conducting Green ICT benchmarking. It contains four vertical components, or 'pillars', each of which is broken further into specific areas of Green ICT; and five horizontal components, or 'actions' which describe separate approaches to the verticals.

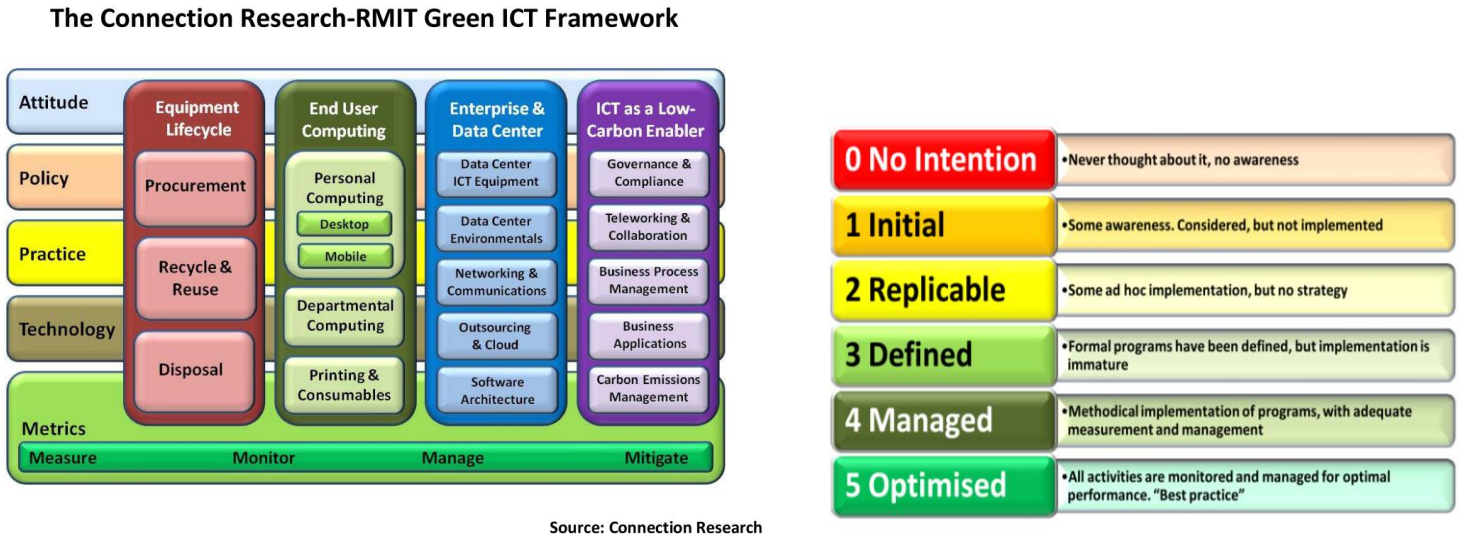

Figure 12. RMIT Green ICT framework

Measurement:
Measurement tool on every aspect of green ICT, for every item in the four pillars. Every question is given a 0-5 score on the CMM scale. The scores for each question are added to each pillar, a weighting is applied, which results in a score for the pillar. The results of the measurement can be used to compare to other organisations (benchmarking).

Appendix 7.4. Capability Maturity Framework for SICT (Donnellan et al., 2011)

- Researcher: Donnellan, Sheridan, Curry
- Year: 2011
- Description:
    - A consortium of leading organisations from industry, the non-profit sector, and academia has developed and tested a framework for systematically assessing and improving **Sustainable Information and Communication Technology (SICT)** capabilities. The IT-Capability Maturity Framework (IT-CMF) is a high-level process capability maturity framework for managing the IT function within an organisation to deliver greater value from IT by assessing and improving a broad range of management practices. The framework identifies 33 critical IT processes and describes an approach to designing maturity frameworks for each process. A core function of the IT-CMF is to act as an assessment tool and a management system with associated improvement roadmaps that guide senior IT and business management in selecting strategies to continuously improve, develop, and manage the IT capability in support of optimised business value delivery.
    - The SICT framework consist of nine building blocks in 4 categories: strategy and planning, process management, people and culture, and governance and control.
- Maturity levels
    - The framework defines a five-level maturity curve for identifying and developing SICT capabilities:

    - Initial: SICT is ad hoc; there's little under- standing of the subject and few or no related policies. Accountabilities for SICT are not defined, and SICT is not considered in the systems life cycle.
    - Basic: There is a limited SICT strategy with associated execution plans. It is largely reactive and lacks consistency. There is an increasing awareness of the subject, but accountability is not clearly established. Some policies might exist but are adopted inconsistently.
    - Intermediate: A SICT strategy exists with associated plans and priorities. The organisation has developed capabilities and skills and encourages individuals to contribute to sustainability programs. The organisation includes SICT across the full systems life cycle, and it tracks targets and metrics on an individual project basis
    - Advanced: Sustainability is a core component of the IT and business planning life cycles. IT and business jointly drive programs and progress. The organisation recognises SICT as a significant contributor to its sustainability strategy. It aligns business and SICT metrics to achieve success across the enterprise. It also designs policies to enable the achievement of best practices.
    - Optimising: The organisation employs SICT practices across the extended enterprise to include customers, suppliers, and partners. The industry recognises the organisation as a sustainability leader and uses its SICT practices to drive industry standards
- Measurement: a 30-minute assessment tool for IT and business management who are responsible for SICT. In addition, focused interviews are done to support the results, to enhance the results of the study. Outcomes and Key performance metrics are identified.
- The SICT-CMF is an assessment tool, that includes a plan for improvement, to support the IT and business managers.

Appendix 7.5. Green ICT Maturity Model for Czech SMEs (Buchalcevova, 2015)

- Researcher: Buchalcevova
- Year: 2016
- Description
    - The GICTM4SME has four domains: greening of ICT; greening by ICT; people and culture; governance and controls.
    - Greening of ICT has the components: ICT procurement, end user computing (computers); end user computing (peripheral equipment, enterprise computing and end-of-life for ICT use.
    - The greening by ICT has six components: CO_2 emissions management, dematerialisation, smart motors, smart buildings, smart logistics, smart energy
    - People and culture components are Roles and Motivations, and Communication and Education
    - Governance consists of Strategy and External Compliance
- Maturity levels (per Philipson)
    - 0 - No intention - Never thought about it, no awareness
    - 1 – Initial - Some awareness. Considered, but not implemented
    - 2 – Replicable - Some ad hoc implementation, but no strategy
    - 3 – Defined - Formal programs have been defined, but implementation is immature
    - 4 – Managed – Methodical implementation of programs, with adequate measurement and management
    - 5 - Optimised – All activities are monitored and managed for optimal performance
- Measurement: Web application where companies can complete a self-evaluation

Appendix 7.6. Governance and Management Framework for Green ICT (Patón-Romero et al., 2017)

- Researcher: Paton
- Year: 2017
- Description
    - This framework is based on COBIT (Control objectives for information and related technology), a generic framework to control and audit IT related areas. The results obtained through different validations demonstrate the validity and usefulness of the framework developed in the field of Green ICT, providing a complete guide to the organisations in their efforts to implement, control and/or improve the practices of Green ICT in their processes and day-to-day operations. COBIT 5 has a set of guidelines and best practices for the governance and management of different areas of IT.
    - COBIT 5 establishes a series of enablers, which define the organisational resources for the government and management of a certain area of IT, including for Green ICT:
        - Principles, policies, and frameworks are the fundamental means to convert the desired behaviour into practical guides for day-to-day management. In short, they are the communication mechanisms used to transmit the direction and instructions of the government and management bodies.
        - Processes: are considered as an organised set of activities designed to achieve certain objectives and produce a set of results that support the general goals related to IT.
        - Organisational structures: are the key decision-making bodies in an organisation.
        - Culture, ethics, and behaviour are a set of individual and collective behaviours of people and organisation.
        - Information: is essential for the survival of the organisation and its good governance. COBIT 5 notes that, at the operational level, information is the key product of the organisation itself.
        - Services, infrastructure, and applications: provide services and information processing technologies to the organisation.
        - People, skills and competencies are related to people; these are needed if all activities are to be completed satisfactorily and so that decision-making and corrective actions can be carried out properly.
    - COBIT 5 establishes a total of 37 processes organised in five domains, which in turn are divided into two large areas:
        - Governance – evaluate, direct and monitor
        - Management
            - Align, Plan and Organise (APO): 13 processes.
            - Build, Acquire and Implement (BAI): 10 processes.
            - Deliver, Service and Support (DSS): 6 processes.
            - Monitor, Evaluate and Assess (MEA): 3 processes
- Maturity levels
    - COBIT has 3 level of maturity for IT organisations
- Measurement through interviews

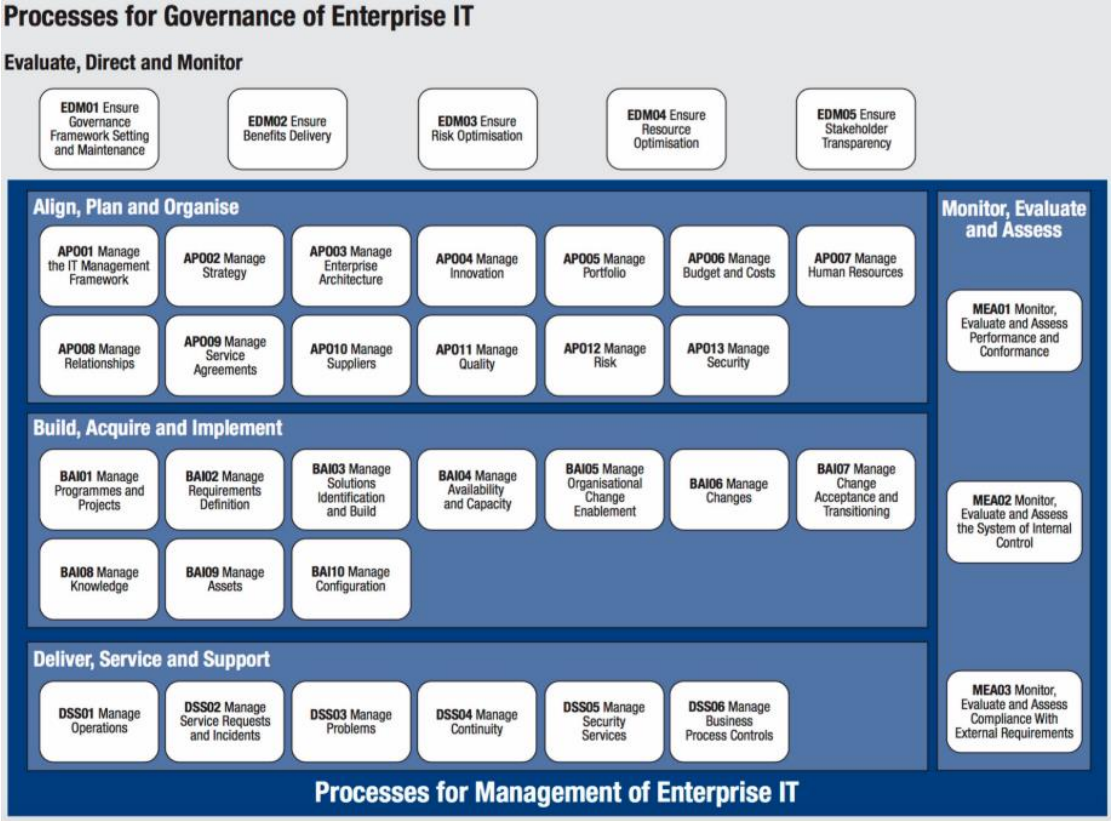

Figure 13. Processes for governance of IT processes, COBIT (Lautenschutz et al., 2018)

Appendix 7.7. Practice Oriented Green IS Framework (Butler, 2011)

- Researcher: Butler
- Year: 2011

- Description
- Addresses need for a comprehensive, practice-oriented Green IS-framework
- Goal is to aid organisations in implementing green initiatives in several domains, which in turn lower overall the emissions of Greenhouse Gas (GHG).
- Green ICT is described to be a part of Organisational Governance of an organisation and is named the 'Green Business and IS strategy
- Starting point is Green Business and IS strategy
    - Domains are People, Energy Efficiency, Dematerialisation, Waste and Recycling and Green Operations
    - Each has several attributes
    - See picture below
- Maturity levels and Measurement
- Since this framework is conceptual, Butler does not elaborate on how to use this framework. The description stays high level with words like 'evaluating progress across the key areas.' Companies can decide how they wish to evaluate the key areas

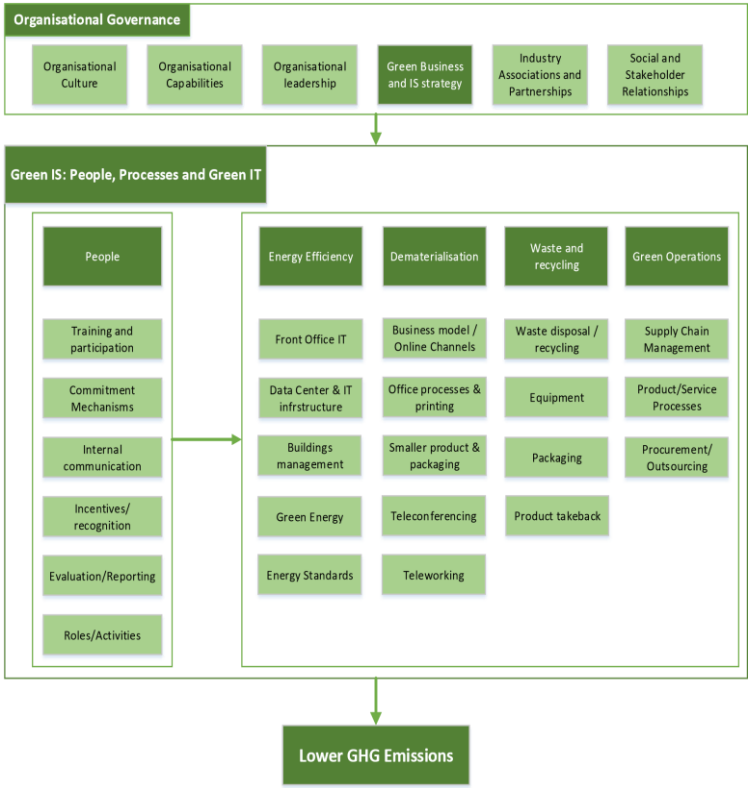

Figure 14. Green IS Framework (Butler, 2011)

Appendix 7.8. Holistic Approach to Green ICT (Murugesan & Gangadharan, 2012)

- Researcher: Murugesan and Gangadharan
- Year: 2012
- Description
    - Framework to address the environmental impacts of IT comprehensively and efficiently.
    - Developed to achieve sustainability from the IT side and making IT greener through its entire lifecycle
    - Green IT has three dimensions:
        - Greening the hardware and usage of IT

        - Using IT to improve sustainability in different domains
        - Using IT to make people more aware of sustainability
    - Six domains:
        - Green Use: Reducing the energy consumption of computers and using them in an environmentally sound manner. This includes using practices like reducing power consumption, using power management, and turning off the computers when not in use.
        - Green disposal: Refurbishing and reusing old computers and properly recycling unwanted IT components.
        - Green Design: The designing off energy efficient and environmentally sound components, computers, servers, and cooling equipment.
        - Green Manufacturing: Manufacturing of electronic components, computers, and other associated subsystems with as little impact as possible on the environment.
        - Green Strategies and Policies: Effective and actionable strategies and policies that add value and focus on both long and short-term benefits. These are aligned with business strategies, practices and are key components of greening IT in an organisation.
        - Green Standards and metrics: These are required for promotion, comparison and benchmarking of sustainability initiatives, products, services, and practices.
- Maturity levels and Measurement
    - Framework provides no maturity levels or measurement tools

Appendix 7.9. Green ICT Framework for Greening Datacentres (Uddin & Rahman, 2012)

- Researcher: Uddin and Rahman
- Year: 2012
- Description
    - Data Centre focus: Data centres are a major source of IT's GHG emissions and an important issue in reducing the energy consumption of IT. Need for reducing the power consumption of data centres.
    - The framework is structured as a process with 5 different phases, which each containing different artifacts.
        1. Plan and Diagnose
        2. Identification and categorisation
        3. Recycle and low carbon enabler
        4. Implementation
        5. Analysis
- Maturity levels and Measurement
    - Framework provides no maturity levels or measurement tools

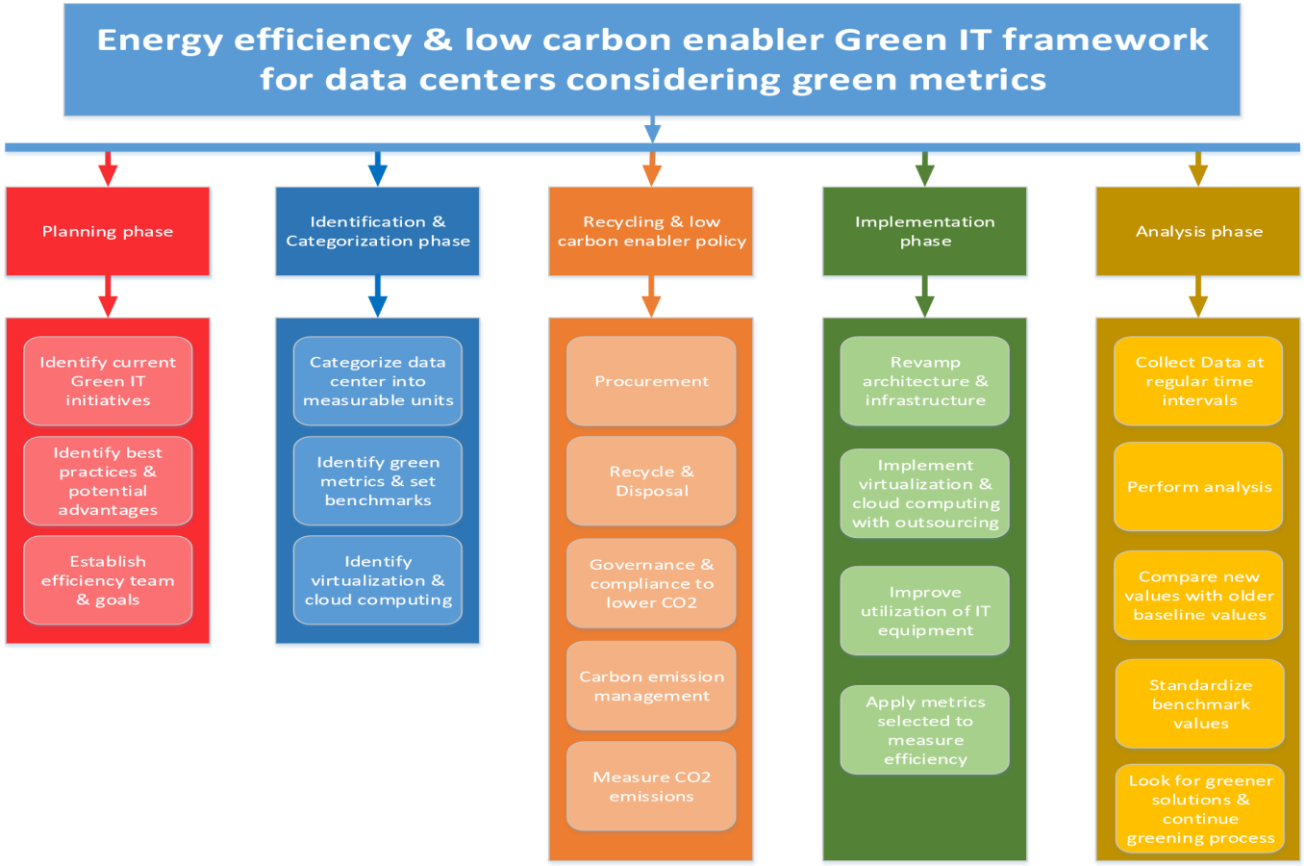

Figure 15. Artifacts of Uddin's Framework (Uddin & Rahman, 2012)

Appendix 8. Green ICT Maturity Model Assessments with Criteria from Becker and Pöppelbuß

In this appendix, the identified Green ICT maturity models are assessed using Becker's and Pöppelbuß' maturity model criteria (Becker et al., 2009; Pöppelbuß & Röglinger, 2011).

Table 27. *Nine Green ICT Maturity Models' Assessment with Becker's Requirements and Pöppelbuß' Design Principles*

	Maturity Model	Assessed per Becker's Requirements	Assessed per Pöppelbuß's Design Principles
1	SURF Green ICT Maturity Model (Hankel et al., 2017)	✓ R1 – Comparison with existing maturity models – Comparison with Capability Maturity Model (Paulk & Curtis, 1993) and other Green ICT maturity models (Lautenschutz et al., 2018) ✓ R2 – Iterative procedure – Development of models with literature review and interviews (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) ✓ R3 – Evaluation – Application in case studies. Versions were made available for review. Feedback from industry sectors and validation in workshops/ interviews – educations, banks, retail (Hankel et al., 2017, 2014; Hubers, 2019; Siebes, 2019) ✓ R4 – Multi-methodologic procedure – Literature review. Expert interviews. Analysis and comparison to other models (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) ✓ R5 – Identification of problem relevance - the Dutch higher education and research partnership for ICT, decided to develop a maturity model on Green ICT after interviewing Dutch higher education and research institutions. In these interviews the institutions expressed a clear need for some way to know how well they are doing in terms of Green ICT (Hankel et al., 2014) ✓ R6 – Problem definition – Evaluation of education organisations providing analysis. Developed a tool for the evaluation and improvement of Green ICT in organisations. Support of IT management (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) ✓ R7 – Target presentation of results – website, publicly available MS Excel based tool; academic publications describing model, notes and design process (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018; SURF, 2015) ✓ R8 – Scientific documentation (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018)	Basic principles ✓ Basic information – academic publication provide evidence of application domain and applicability, purpose of use, target group, class of entities, differentiation from related maturity models, design process and extent of empirical validation (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) ✓ Attributes for maturity and maturation – academic publications provide evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation, underpinning theoretical foundations with respect to evolution and change (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) ✓ Clear definition of the attributes for application domain (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) ✓ Clear definition of target group oriented documentation (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018; SURF, 2015) Descriptive design principles ✓ Verifiable criteria for each maturity level – some evidence provided in academic pubications but more research required (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018; SURF, 2015) ✓ Target group oriented assessment methodology – academic publications provide evidence of the procedure model, getting advice on the assessment of criteria and adaptation and configuration of criteria, and expert knowledge from previous application (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) Prescriptive design principles (Hankel et al., 2017, 2018, 2014; Lautenschutz et al., 2018) • Improvement measures by level – for this model, there is some evidence that this prescriptive design principle applies • Decision calculus – for this model, there is some evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is some evidence that this prescriptive design principle applies
2	Green ICT Readiness framework (Molla & Cooper, 2010)	✓ R1 – Comparison with existing maturity models – Comparison with Infotech and Gartner papers (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ R2 – Iterative procedure – Development of models with literature review and interviews, for Green ICT and e-readiness; and the evidence of concept	Basic principles ✓ Basic information – academic publication provide evidence of application domain and applicability, purpose of use, target group, class of entities, differentiation from related maturity models, design process and extent of empirical validation (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010)

	Maturity Model	Assessed per Becker's Requirements	Assessed per Pöppelbuß's Design Principles
		from ANZ, Australia Post, BHP and Telstra (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ R3 – Evaluation – Application in case studies - the evidence of concept from ANZ, Australia Post, BHP, and Telstra. Versions were made available for review. Feedback from industry sectors and validation. Additional points made in referenced articles (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ R4 – Multi-methodologic procedure – Literature review. Expert interviews. explored secondary sources of four large well-known Australian organisations to demonstrate the practical relevance of each of the dimensions of the G-readiness framework. Use of structure frameworks and procedures, Reviews of Green ICT white papers and consultants' reports. Desk research on the Green ICT strategies of seven companies. Additional points made in referenced articles (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ R5 – Identification of problem relevance – academic publications state 'the requirement that IT management turn to Green ICT solutions' (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ R6 – Problem definition – Advance Green ICT research through theorisation, model construction and measurement development. Developed a tool for the evaluation and improvement of Green ICT in organisations. Support of IT management (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ R7 – Target presentation of results – academic publications describing model, notes and design process (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010; Molla et al., 2011) ✓ R8 – Scientific documentation - The conceptual G-readiness framework was developed by applying understanding from extant literature on E-readiness and Corporate Social Responsibility (CSR), along with extant literature and practitioner publications investigating issues surrounding Green ICT, such as the adoption of green supply chain practices. Review of practitioner oriented Green ICT publications and literature on the adoption of green process technologies, green supply chain practices and e-readiness (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010)	✓ Constructs for maturity and maturation – academic publications provide evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation, underpinning theoretical foundations with respect to evolution and change. The model has a high level index, five component indexes, 10-sub indexes and 32 items (Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ Clear definition of the constructs for application domain (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ Definition of target group oriented documentation (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) Descriptive design principles ✓ Criteria for each maturity level – the model has a high level index, five component indexes, 10-sub indexes and 32 items. Can be used as a decision tool to locate, measure and manage Green ICT capability and identify strategies to improve (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) ✓ Target group oriented assessment methodology – academic publications provide evidence of the procedure model (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) Prescriptive design principles • Improvement measures by level - Can be used as a decision tool to locate, measure and manage Green ICT capability and identify strategies to improve (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) • Decision calculus – for this model, there is some evidence that this prescriptive design principle applies (Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010) • Decision metholodology – for this model, there is some evidence that this prescriptive design principle applies(Cooper & Molla, 2017; Molla & Cooper, Vanessa Pittayachawan, 2009; Molla & Cooper, 2010)
3	Green ICT framework and capability maturity model (Philipson, 2010)	• R1 – Comparison with existing maturity models – only reference to CMMI – not compared to other Green ICT maturity models • R2 – Iterative procedure – no evidence in the academic literature that this was developed through an iterative process ✓ R3 – Evaluation - Academic paper mentions that this is a mature, tested and practical framework, and mentions surveying over 500 organisations; little specific evidence available in the literature (Philipson, 2010) • R4 – Multi-methodologic procedure – no evidence in the academic literature	Basic principles (Philipson, 2010) • Basic information – academic publication provide some evidence of application domain and applicability, purpose of use, class of entities, design process and extent of empirical validation • Constructs for maturity and maturation – academic publications provide evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation. The model has four pillars and five actions • Some definition of the constructs for application domain • Some definition of target group oriented documentation

	Maturity Model	Assessed per Becker's Requirements	Assessed per Pöppelbuß's Design Principles
		• R5 – Identification of problem relevance – no evidence in the academic literature ✓ R6 – Problem definition – Is described in the article but no definition of Green ICT (Philipson, 2010) • R7 – Target presentation of results – no evidence in the academic literature ✓ R8 – Scientific documentation (Philipson, 2010)	Descriptive design principles (Philipson, 2010) ✓ Criteria for each maturity level – Use CMM levels. Can be used as a decision tool to measure and manage Green ICT capability – not well explained ✓ Target group oriented assessment methodology – some evidence provided Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies
4	Capability Maturity framework for Sustainable Information and Communication technology (Curry & Donnellan, 2012; Donnellan et al., 2011)	• R1 – Comparison with existing maturity models - complements existing approaches for measuring SICT maturity, such as the G-readiness framework (which provides a benchmark score against SICT best practices) or the Gartner Green ICT Score Card (which measures corporate social responsibility compliance). It offers a comprehensive value-based model for organising, evaluating, planning, and managing SICT capabilities, and it fits within the IVI's IT-Capability Maturity Framework (IT-CMF) (Curry & Donnellan, 2012) • R2 – Iterative procedure - The development of the SICT-CMF was undertaken using a design process with de- fined review stages and development activities based on the Design Science Re- search (DSR) guidelines advocated by Hevner et al. During the design process, researchers participate together with practitioners within research teams to capture the views of key domain experts. (Curry & Donnellan, 2012) ✓ R3 – Evaluation - Over 2009-2011 member organisations of the IVI have applied the maturity framework to better understanding of their sustainable IT maturity. The assessment providing them with insights into what they are doing well and where they needed to improve. (Curry & Donnellan, 2012) • R4 – Multi-methodologic procedure – no evidence in the academic literature ✓ R5 – Identification of problem relevance: A core function of the IT-CMF is to act as an assessment tool and a management system with associated improvement roadmaps that guide senior IT and business management in selecting strategies to continuously improve, develop, and manage the IT capability in support of optimised business value delivery. (Curry & Donnellan, 2012) ✓ R6 – Problem definition - There is a need to improve the sustainable IT behaviours, practices, and processes within organisations to deliver greater value from Sustainable IT. To ad- dress the issue, a consortium of leading organisations from industry, the non-profits sector, and academia decided to develop a framework for systematically assessing and improving SICT	Basic principles • Basic information – academic publication provide evidence of application domain and applicability, purpose of use, target group, class of entities, differentiation from related maturity models, design process and extent of empirical validation (Curry & Donnellan, 2012; Donnellan et al., 2011) • Constructs for maturity and maturation – academic publications provide evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation. The model has 32 critical IT processes (Curry & Donnellan, 2012; Donnellan et al., 2011) • Some definition of the constructs for application domain (Curry & Donnellan, 2012; Donnellan et al., 2011) • Some definition of target group oriented documentation (Curry & Donnellan, 2012; Donnellan et al., 2011) Descriptive design principles (Curry & Donnellan, 2012; Donnellan et al., 2011) ✓ Criteria for each maturity level – Use CMM levels. Can be used as a decision tool to measure and manage Green ICT capability – not well explained ✓ Target group oriented assessment methodology – some evidence provided Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies

	Maturity Model	Assessed per Becker's Requirements	Assessed per Pöppelbuß's Design Principles
		capabilities. The core of this framework is a maturity model for Sustainable ICT which provides a management system with associated improvement roadmaps that guide senior IT and business management in selecting strategies to continuously improve, develop, and manage the sustainable IT capability (Curry & Donnellan, 2012) • R7 – Target presentation of results – no evidence in the academic literature ✓ R8 – Scientific documentation (Curry & Donnellan, 2012; Donnellan et al., 2011)	
5	Green ICT Maturity Model for Czech SMEs (Buchalcevova, 2015)	✓ R1 – Comparison with existing maturity models – described in section 3.2 of (Buchalcevova, 2015) ✓ R2 – Iterative procedure – described in section 3.3 of (Buchalcevova, 2015) ✓ R3 – Evaluation – described in section 4 (Buchalcevova, 2015) • R4 – Multi-methodologic procedure – no evidence in the academic literature • R5 – Identification of problem relevance – no evidence in the academic literature ✓ R6 – Problem definition – described in section 3.1 of (Buchalcevova, 2015) • R7 – Target presentation of results – no evidence in the academic literature ✓ R8 – Scientific documentation (Buchalcevova, 2015)	Basic principles ✓ Basic information – described in section 3 of (Buchalcevova, 2015) ✓ Constructs for maturity– described in section 3 of (Buchalcevova, 2015) ✓ Constructs for application domain– described in section 3 of (Buchalcevova, 2015) ✓ Documentation– described in section 3 of (Buchalcevova, 2015) Descriptive design principles ✓ Criteria for each maturity level – described in section 3 of (Buchalcevova, 2015) ✓ Assessment methodology – described in section 3 of (Buchalcevova, 2015) Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies
6	Governance and Management Framework for Green ICT (Patón-Romero et al., 2017)	• R1 – Comparison with existing maturity models – Paton concludes that practically no studies exist related to governance and management of Green ICT (Patón-Romero et al., 2017) ✓ R2 – Iterative procedure – based on COBIT, which has been iteratively developed over many years • R3 – Evaluation – two case studies (Patón-Romero et al., 2017) • R4 – Multi-methodologic procedure– no evidence in the academic literature • R5 – Identification of problem relevance– no evidence in the academic literature • R6 – Problem definition– no evidence in the academic literature • R7 – Target presentation of results– no evidence in the academic literature ✓ R8 – Scientific documentation (Patón-Romero et al., 2017). More academic literature exists by Paton, but it was accessible through the library	Basic principles ✓ Basic information – academic publication provide evidence of application domain and applicability, purpose of use, target group, class of entities, differentiation from related maturity models, design process and extent of empirical validation ((Patón-Romero et al., 2017) ✓ Constructs for maturity and maturation – academic publications provide evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation. 37 processes in 5 domains, in two large areas of Governance and Management (David Patón-Romero et al., 2017) ✓ Some definition of the constructs for application domain (David Patón-Romero et al., 2017) ✓ Some definition of target group oriented documentation (David Patón-Romero et al., 2017) Descriptive design principles • Criteria for each maturity level – for this model, there is no evidence that this descriptive design principle applies • Target group oriented assessment methodology – for this model, there is no evidence that this descriptive design principle applies

	Maturity Model	Assessed per Becker's Requirements	Assessed per Pöppelbuß's Design Principles
			Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies
7	Practice oriented Green IS framework (Butler, 2011)	• R1 – No comparison with existing maturity models – No evidence found that the framework was compared with existing models ✓ R2 – Iterative procedure – several iterations through field studies • R3 – Evaluation – field study • R4 – Multi-methodologic procedure– no evidence in the academic literature • R5 – Identification of problem relevance– no evidence in the academic literature • R6 – Problem definition– organisation to become greener in the different domains • R7 – Target presentation of results– no evidence in the academic literature • R8 – Scientific documentation (Butler, 2011).	Basic principles ✓ Basic information – academic publication provide evidence of application domain and applicability, purpose of use, class of entities, differentiation, design process and extent of empirical validation ✓ Constructs for maturity and maturation – academic publications provide no evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation. ✓ Definitions of the constructs for application domain ✓ Some definition of target group oriented documentation Descriptive design principles • Criteria for each maturity level – for this model, there is no evidence that this descriptive design principle applies • Target group oriented assessment methodology – for this model, there is no evidence that this descriptive design principle applies Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies
8	Holistic approach to Green ICT (Murugesan & Gangadharan, 2012)	✓ R1 – Comparison with existing maturity models – No comparison • R2 – Iterative procedure – some iterations between 2008 and 2012 • R3 – Evaluation – except for the book, no evidence • R4 – Multi-methodologic procedure– no evidence in the academic literature • R5 – Identification of problem relevance– no evidence in the academic literature • R6 – Problem definition– no evidence in the academic literature • R7 – Target presentation of results– no evidence in the academic literature • R8 – Scientific documentation – the book	Basic principles ✓ Basic information – academic publication provide evidence of application domain and applicability, purpose of use, target group, class of entities ✓ Constructs for maturity and maturation – academic publications provide no evidence of maturity and dimensions of maturity, maturity levels and path, available level of granularity of maturation. ✓ Some definition of the constructs for application ✓ Some definition of target group oriented Descriptive design principles • Criteria for each maturity level – for this model, there is no evidence that this descriptive design principle applies • Target group oriented assessment methodology – for this model, there is no evidence that this descriptive design principle applies

	Maturity Model	Assessed per Becker's Requirements	Assessed per Pöppelbuß's Design Principles
			Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies
9	Green ICT framework for greening Datacenters (Uddin & Rahman, 2012)	✓ R1 – Comparison with existing maturity models – No comparison ✓ R2 – Iterative procedure – several iterations • R3 – Evaluation – one case study 2012 • R4 - Multi-methodologic procedure– no evidence in the academic literature • R5 – Identification of problem relevance– no evidence in the academic literature • R6 – Problem definition– no evidence in the academic literature • R7 – Target presentation of results– no evidence in the academic literature • R8 – Scientific documentation – several articles	Basic principles ✓ Basic information – academic publication provide evidence of application domain and applicability, purpose of use, target group, class of entities, ✓ Constructs for maturity and maturation – no evidence ✓ Some definition of the constructs for application domain ✓ Some definition of target group oriented documentation Descriptive design principles • Criteria for each maturity level – for this model, there is no evidence that this descriptive design principle applies • Target group oriented assessment methodology – for this model, there is no evidence that this descriptive design principle applies Prescriptive design principles • Improvement measures by level – for this model, there is little evidence that this prescriptive design principle applies • Decision calculus – for this model, there is no evidence that this prescriptive design principle applies • Decision metholodology – for this model, there is no evidence that this prescriptive design principle applies

Appendix 9. Attributes Coverage for Green ICT Maturity Models

Maturity models are conceptual models based on the idea that organisational capabilities develop through a sequence of anticipated, desired, or logical stages from an initial to a more mature state. The basic components of a maturity model are:

1. maturity levels,
2. a set of dimensions, aspects, concepts, key process areas or functional areas (we will refer to them as attributes) that can be developed along a predefined evolutionary path to achieve the defined maturity levels, and
3. descriptions of each step on the path typically consisting of guidelines, key processes, or best practices.

A maturity model in the context of Green ICT is a framework for systematically assessing and improving sustainable ICT capabilities within organisations. So far, no systematic comparison of the available Green ICT maturity models has been performed. Lautenschutz et al. (2018) collected and analysed several Green ICT maturity models and conceptual frameworks and devised a method that identifies the similarities and differences between the models. Among other comparisons, the attributes were mapped across the different models.(Lautenschutz et al., 2018)

While comparing the attributes, a matrix was constructed. This matrix supported the comparison and served to present the results. The columns of the matrix are the maturity models being compared. To facilitate the comparison process, the first column corresponds to the pivot model. The upper row contains the names of the maturity models and its attributes are listed in the cells underneath. Two attributes from two maturity models are in the same row when they are equivalent. A cell of a maturity model can be empty when it misses a attribute present in other models. This can be also represented with an X or any other convention. When there is a difference in the granularity of the attributes, then the cells from several rows can be merged for the model that contains the most generic attribute.

The comparison matrix below was taken from Lautenschutz et al. (2018). It was enhanced with two additional models, column 5 with the Green ICT maturity models for SME's (Buchalcevova, 2015) and column 6 with the Governance and Management Framework for Green ICT (Patón-Romero et al., 2017). The values in the comparison matrix for these two models were derived after review of the two references articles – Lautenschutz et al. (2018) applied significant rigor for determining the values for their models, which was not done for this thesis.

Table 28. *Attributes Coverage of the Nine Green ICT maturity models*

Comparison	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Attributes (Lautenschutz et al., 2018)	**SURF Green ICT maturity model** (Hankel et al., 2017)	**G-Readiness framework** (Molla & Cooper, 2010)	**Green ICT framework and capability maturity model** (Philipson, 2010)	**Capability Maturity framework for Sustainable information and communication technology** (Curry & Donnellan, 2012)	**Green ICT maturity models for Czech SMEs** (Buchalcevova, 2015)	**Governance and Management framework for Green ICT** (Patón-Romero et al., 2017)	**Practice oriented Green IS framework** (Butler, 2011)	**Holistic approach to Green ICT** (Murugesan & Gangadharan, 2012)	**Green ICT framework for greening Datacenters** (Uddin & Rahman, 2012)
General business issues									
Green ICT strategy	Green ICT strategy		Governance and compliance	Strategy and planning	Strategy	Manage strategy; Policy of Green ICT; Policy of compliance; Policy of conduct	Green business and IS strategy and Business model and Online channels	Green ICT strategies and policies	
Governance of ICT services	Governance of ICT services	Governance	Governance and compliance	Corporate policies	Governance: internal and external indicators of Green ICT governance	Policy of Green ICT Governance processes: Governance framework, Benefits delivery, risk and resource optimisation; stakeholder transparency; manage requirements; manage performance and conformance	Organisation governance		
Green ICT procurement	Green ICT procurement	Attitude, policy, practice	Procurement	Operations and life cycle	ICT procurement	Policy of acquisition development and maintenance of IT systems	Procurement / IT outsourcing		Procurement
E-waste policy	E-waste policy	Attitude, policy, practice, technology	Disposal, recycle and reuse	Operations and life cycle	End of ICT use	Policy of resource management; Policy of asset management	Waste/ disposal / recycling	Green disposal of IT systems	Recycle and disposal

Comparison	1	2	3	4	5	6	7	8	9
Attributes (Lautenschutz et al., 2018)	**SURF Green ICT maturity model** (Hankel et al., 2017)	**G-Readiness framework** (Molla & Cooper, 2010)	**Green ICT framework and capability maturity model** (Philipson, 2010)	**Capability Maturity framework for Sustainable information and communication technology** (Curry & Donnellan, 2012)	**Green ICT maturity models for Czech SMEs** (Buchalcevova, 2015)	**Governance and Management framework for Green ICT** (Patón-Romero et al., 2017)	**Practice oriented Green IS framework** (Butler, 2011)	**Holistic approach to Green ICT** (Murugesan & Gangadharan, 2012)	**Green ICT framework for greening Datacenters** (Uddin & Rahman, 2012)
Green ICT in Information management and Architecture	Green ICT in Information management and Architecture			ICT enabled business processes. Performance and reporting		Architecture of Green ICT Policy of asset management; manage solutions identification and build			
Community Collaboration	Community Collaboration			External compliance	External compliance	Manage relationships; Compliance with external requirements			
Green ICT supply chain management	Green ICT supply chain management	Policy	Business process management	ICT enabled business processes	Smart logistics; manage operations		Supply chain management		
Green of ICT (Green ICT)									
Housing	Housing	Attitude	Data centre environmental	Operations and life cycle. Performance and reporting	Smart buildings	Manage solutions identification and build	Building management systems	Green use of IT systems	
Computing infrastructure	Computing infrastructure	Policy, practice, technology	Data centre environmental	Operations and life cycle. Performance and reporting	Enterprise computing	Manage solutions identification and build	Data centre and IT infrastructure	Green use of IT systems	Revamp architecture and infrastructure
Network infrastructure	Network infrastructure	Attitude, practice, technology	Networking and communications	Operations and life cycle. Performance and reporting	Enterprise computing	Manage solutions identification and build	Data centre and IT infrastructure	Green use of IT systems	Revamp architecture and infrastructure
Storage infrastructure	Storage infrastructure	Attitude, practice, technology	Data centre environmental	Operations and life cycle. Performance and reporting	Enterprise computing	Manage solutions identification and build	Data centre and IT infrastructure	Green use of IT systems	Revamp architecture and infrastructure

Comparison	1	2	3	4	5	6	7	8	9
Attributes (Lautenschutz et al., 2018)	**SURF Green ICT maturity model** (Hankel et al., 2017)	**G-Readiness framework** (Molla & Cooper, 2010)	**Green ICT framework and capability maturity model** (Philipson, 2010)	**Capability Maturity framework for Sustainable information and communication technology** (Curry & Donnellan, 2012)	**Green ICT maturity models for Czech SMEs** (Buchalcevova, 2015)	**Governance and Management framework for Green ICT** (Patón-Romero et al., 2017)	**Practice oriented Green IS framework** (Butler, 2011)	**Holistic approach to Green ICT** (Murugesan & Gangadharan, 2012)	**Green ICT framework for greening Datacenters** (Uddin & Rahman, 2012)
End user ICT equipment (PCs, printers, etc)	End user ICT equipment (PCs, printers, etc)	Policy, technology	End user computing	Operations and life cycle. Performance and reporting	End-user computing (computers, printers, other equipment)	Manage solutions identification and build	Front office IT	Green use of IT systems	
Software and ICT services	Software and ICT services	Technology	Outsourcing and cloud	Operations and life cycle. Performance and reporting; manage operations		Manage solutions identification and build	Procurement / IT outsourcing	Green use of IT systems	Identify virtualisation and cloud computing. Implement virtualisation and cloud computing with outsourcing
Greening of operations with ICT; Greening by IT (Green IS)									
Travel reductions with ICT	Travel reductions with ICT		Teleworking and collaboration	ICT enabled business processes	Carbon emissions management		Teleconferencing and teleworking	Green use of IT systems	
Area reductions with ICT	Area reductions with ICT			ICT enabled business processes	Smart buildings			Green use of IT systems	
Energy reductions with ICT	Energy reductions with ICT	Attitude, policy, technology		ICT enabled business processes	Smart energy		Environmental management system	Green use of IT systems	
Paper reduction with ICT	Paper reduction with ICT	Practice, technology	Printing and consumables	ICT enabled business processes			Office processes and printing	Green use of IT systems	
Feedback and decision support	Feedback and decision support	Attitude, policy, practice	Metrics	Performance and reporting			Building management systems. Product/ Service operations	Green use of IT systems	Analysis phase

Comparison	1	2	3	4	5	6	7	8	9
Attributes (Lautenschutz et al., 2018)	**SURF Green ICT maturity model** (Hankel et al., 2017)	**G-Readiness framework** (Molla & Cooper, 2010)	**Green ICT framework and capability maturity model** (Philipson, 2010)	**Capability Maturity framework for Sustainable information and communication technology** (Curry & Donnellan, 2012)	**Green ICT maturity models for Czech SMEs** (Buchalcevova, 2015)	**Governance and Management framework for Green ICT** (Patón-Romero et al., 2017)	**Practice oriented Green IS framework** (Butler, 2011)	**Holistic approach to Green ICT** (Murugesan & Gangadharan, 2012)	**Green ICT framework for greening Datacenters** (Uddin & Rahman, 2012)
Greening of primary insurancw processes									
Marketing	Marketing								
Product development	Product development								
Sales	Sales								
Underwriting	Underwriting								
Contract administration	Contract administration								
Customer service	Customer service								
Claim management	Claim management								
Asset and Risk management	Asset and Risk management								
Non matching constructs									
People				People and culture	People and Culture: Defining roles of Green ICT, motivation, and communication of information	Training in Green ICT	People		

Comparison	1	2	3	4	5	6	7	8	9
Attributes (Lautenschutz et al., 2018)	**SURF Green ICT maturity model** (Hankel et al., 2017)	**G-Readiness framework** (Molla & Cooper, 2010)	**Green ICT framework and capability maturity model** (Philipson, 2010)	**Capability Maturity framework for Sustainable information and communication technology** (Curry & Donnellan, 2012)	**Green ICT maturity models for Czech SMEs** (Buchalcevova, 2015)	**Governance and Management framework for Green ICT** (Patón-Romero et al., 2017)	**Practice oriented Green IS framework** (Butler, 2011)	**Holistic approach to Green ICT** (Murugesan & Gangadharan, 2012)	**Green ICT framework for greening Datacenters** (Uddin & Rahman, 2012)
GHG emissions management		Attitude: GHG emissions	Carbon emissions management		Carbon emissions management				Governance and compliance to lower CO2. Carbon emissions management. Measure CO2 emissions
Green energy sources		Policy: green sources of energy					Green energy		
Extra waste caused by IT		Practice: extra waster (paper, batteries, etc.)					Smaller product and packaging		
Green standards and metrics						Evaluation and tests of Green ICT	Energy standards	Green standards and metrics	Identify green metrics and set benchmarks
Green production								Green manufacturing of IT systems	
Green design								Green design of IT systems	
Green data centres		Policy: green data centres			Smart buildings				
Shorten refreshment		Practice: shorten refreshments of equipment to increase its efficiency							

Comparison	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Attributes (Lautenschutz et al., 2018)	**SURF Green ICT maturity model** (Hankel et al., 2017)	**G-Readiness framework** (Molla & Cooper, 2010)	**Green ICT framework and capability maturity model** (Philipson, 2010)	**Capability Maturity framework for Sustainable information and communication technology** (Curry & Donnellan, 2012)	**Green ICT maturity models for Czech SMEs** (Buchalcevova, 2015)	**Governance and Management framework for Green ICT** (Patón-Romero et al., 2017)	**Practice oriented Green IS framework** (Butler, 2011)	**Holistic approach to Green ICT** (Murugesan & Gangadharan, 2012)	**Green ICT framework for greening Datacenters** (Uddin & Rahman, 2012)
Corporate social responsibility		Policy: CSR			External compliance				
Data centre specific technologies									Identify virtualisation and cloud computing
Data centre categorisation									Categorise data centre
Software architecture			Software architecture						
Planning					Manage budget and costs				Planning phase
Equipment for waste							Equipment		
Product take back							Product take back		
Social clauses (SOMO)									

Appendix 10. Emails to Interview Respondents

Appendix 10.1. Introductory Email with Request for Interview

To: <Respondent first name> <Respondent last name>

From: Richard Meertens

Date: <date>

Subject: Would you like to participate in my thesis research on Green ICT?

Dear Mr. / Mrs. <Respondent last name>,

To complete my Master's in Business Process Management and IT, I am doing research on measuring the maturity level of Green ICT in the insurance sector. For this I need to complete interviews. I asked <Key Contact> who I could approach to participate in the research. Because of your role within the <Respondent Organisation Name> I would like to interview you.

For the interview you do not require any specific knowledge of Green ICT – I will share background information with you as part of the process. The interview is semi-structured – the questions are focused on a Green ICT maturity model selected and adapted by me for the insurance sector. Your interview responses will be kept confidential and will be shared with you for validation within a week of the interview. Pre-read time will take about 1 hour, plus one hour for the interview (at your office) and about 30 minutes for validating the interview transcript. I would like to tape the interview, with your permission.

Timing:

- Pre-read: I will send you the background information (research overview, Green ICT maturity model, interview questions).
- Interview: my preference would be to conduct the interview in the week of February 10 or 17, 2020.
- Validation of interview transcript: week of February 24 or March 2, 2020.

Please let me know if you can participate in this research. If yes, please let me know what time suits you, and if I can tape the interview. I am planning to schedule my 5 interviews with <Respondent Organisation Name> on the same day as much as possible.

Thank you in advance for your response.

Regards, Richard Meertens

(519) 362-8293

Richard.Meertens@gmail.com

My Background

After completing my computer engineering and MBA degrees, I have mostly worked for insurance companies in project management and CIO roles over the past 25 years, the past 8 years in a consulting role. In 2016 I started a Master's in Business Process Management and IT at the Netherlands Open University.

Green ICT

ICT impacts the environment and climate change. The Global Sustainability Initiative report states that ICT is responsible for 2.3% of global carbon footprint, while ICT solutions could reduce the carbon footprint by up to 16%. Green ICT is as a combination of activities which can minimise the negative impact of ICT on the environment and increase the positive impact from using ICT to optimise business processes.

Insurance companies are ICT-intensive organisations. Insurers need to be competitive and socially responsible and can do this by reducing their environmental footprint. The insurance companies' ICT have direct negative and positive impacts on this footprint. Greening of and by ICT in the insurance sector should have a direct positive impact on the environment. These impacts have not been measurable or comparable over time as insurers don't have a standardised and scientifically relevant framework to measure their impact on the environment, to reduce their environmental footprint and to provide solutions to positively impact the footprint. Since measures are not available, clear and comprehensive insights into the environmental footprint are not available and there is a lack of specific actions for improvement over time. An insurance company should be able to assess its greening of and through ICT. A proven model will enable monitoring of its progress over time.

Appendix 10.2. Pre-read Materials for Interview

To: <Respondent first name> <Respondent last name>

From: Richard Meertens

Date: <date>

Subject: Background information research on measuring the maturity level of Green ICT in the insurance sector

Dear <Respondent>,

ICT impacts the environment and climate change. The Global Sustainability Initiative report states that ICT is responsible for 2.3% of global carbon footprint, while ICT solutions could reduce the carbon footprint by up to 16%. Green ICT is as a combination of activities which can minimise the negative impact of ICT on the environment and increase the positive impact from using ICT to optimise business processes.

Insurance companies are ICT-intensive organisations. Insurers need to be competitive and socially responsible and can do this by reducing their environmental footprint. The insurance companies' ICT have direct negative and positive impacts on this footprint. Greening of and by ICT in the insurance sector should have a direct positive impact on the environment. These impacts have not been measurable or comparable over time as insurers don't have a standardised and scientifically relevant framework to measure their impact on the environment, to reduce their environmental footprint and to provide solutions to positively impact the footprint. Since measures are not available, clear, and comprehensive insights into the environmental footprint are not available and there is a lack of specific actions for improvement over time. An insurance company should be able to assess its greening of and through ICT. A proven model will enable monitoring of its progress over time.

The goal of this graduation research is to select and validate a maturity model for the insurance sector. Researchers have developed several Green IT maturity models. After a pre-selection by fellow students, analysis of seven models took place. One model emerged that can be used as a basis for the sector mentioned above: the SURF Green ICT maturity model (SGIMM) from Hankel et al. (2017). This model distinguished four domains distinguished are: Green ICT in the organisation, Greening of ICT, Greening of Operations with ICT and Greening of primary processes with ICT. The four domains have together 21 attributes and a maturity score for each of these attributes can be determined. The score is based on five levels. As a measuring instrument, this model has a GIMMi measurement tool that will be used for respondent to self-assess. These models are not specific to the insurance industry. Based on the literature study and preliminary research, changes have been made to the selected model. The domain 'greening of primary processes with ICT' has

been adapted for the insurance sector and its primary processes of Marketing, Product Development, Sales, Underwriting, Contract Management and Customer Service, Claim Management, and Risk and Asset Management. The model was further adapted by adding Molla's Green Readiness attributes (Attitude, Policy, Governance, Practice and Technology) and a several attributes identified by Lautenschutz et al. (2018) related to People and Culture, Corporate Social Responsibility, Green energy sources, Green standards and metrics and E-waste management.

To validate the selected and adapted maturity model, empirical research will be conducted with an insurance company in the Canadian insurance sector. Semi-structured interviews will be conducted with six employees at strategic and tactical level, with different expertise and within different departments (business and IT). Before the interview, each respondent will be asked to complete a maturity measurement tool to self-assess the maturity level of the organisation. The model will be discussed during the interview and specific questions will be asked regarding correctness and completeness of the model. The results of the maturity measurement tool will also be discussed. By validating and enhancing the Green ICT model, the model will become a better fit and effective tool for the insurance sector. The result of this research is to have a validated Green ICT maturity model for the insurance sector.

The next table provides a summary of the Green ICT maturity model for the insurance sector. The complete model is attached at the end of the email, which also has the GIMMi self-measurement tool and instructions to fill in the GIMMi self-measurement tool. The summarised results of the GIMMi measurement tool at <Respondent Organisation Name> will provide a view on the maturity of Green ICT at your organisation.

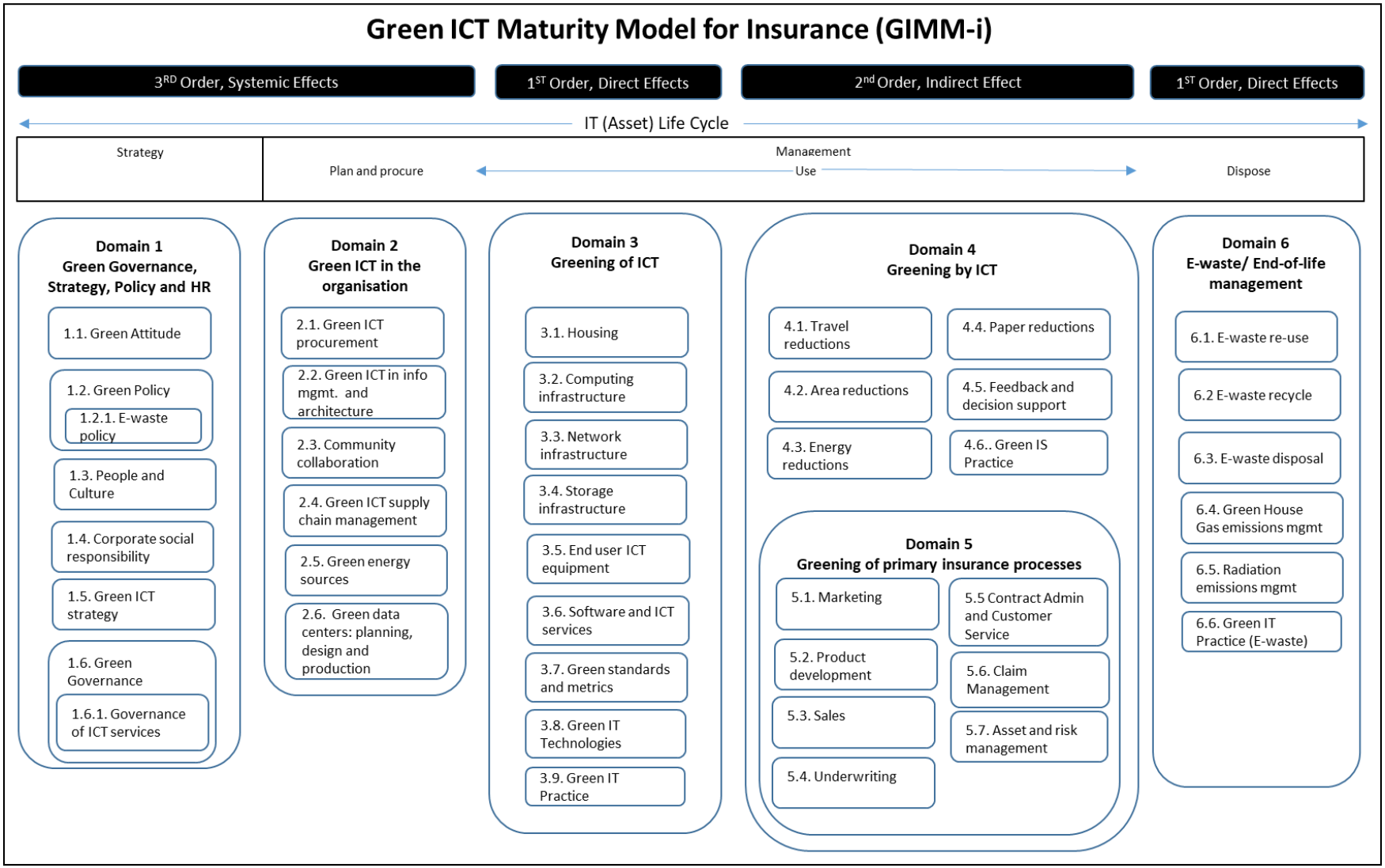

Figure 16. Green ITC Maturity Model for Insurance

The definition of each attribute is provided in Table 29 below. The SURF model (SURF, 2015) provided the definitions of the attributes from the SURF model, and those highlighted in yellow were updated by the researcher. The definitions for the other attributes were obtained from the literature references related to those attributes (see table 10) and these are highlighted in green.

Table 29. *Definition of Attributes*

Attribute		Definition
Domain 1. Green Governance, strategy, Policy and HR		
Green Attitude	1.1	Refers to an organisation's people sentiment, values and norms toward climate change and eco-sustainability and IT's role (Molla, 2012)
Green Policy	1.2	Refers to the environmental criteria and frameworks an organisation puts in place. Includes guiding the sourcing, use, and disposal of the IT technical infrastructure and the activities of IT people (Molla, 2012). Includes e-waste policy An E-waste policy is in use to reuse or recycle ICT equipment. The responsible disposal of used ICT resources (Lautenschuts et al., 2018). An E-waste policy is in use to reuse or recycle ICT equipment. Factors: Policy; Implementation; Scope (Hankel et al., 2014). Enable and demonstrate compliance with ICT and business sustainability legislation and regulation. Require accountability for sustainability roles and decision making across ICT and enterprise matters (Lautenschutz et al., 2018). The organisation has governance process and proactive attitude towards Carbon emissions management
People and culture	1.3	Focused on the human aspect in greening ICT. It involves creating a common language and letting people adopt sustainability in their daily business practices. Adoption - embed sustainability principles across ICT and the extended enterprise (Lautenschutz et al., 2018). Language - Define, communicate, and use common sustainability language and vocabulary across ICT and other business units, including the extended enterprise, to leverage a common understanding (Lautenschutz et al., 2018).
Corporate social responsibility	1.4	The impact the company has on society and environment. Governments, activists and the media have become adept at forcing companies to take the social consequences of their activities into account (Lautenschutz et al., 2018).
Green ICT Strategy	1.5	The organisation has a Green ICT strategy. *Factors: Strategy itself; Use of Strategy; Accessibility; Progress.*
Green Governance	1.6	Refers to the operating model that defines the administration of Green (IT) initiatives, the allocation of budget and other resources and the metrics for assessing the impacts (Molla, 2012). External compliance - Evangelise sustainability successes and contribute to industry best practices (Lautenschutz et al., 2018).
Governance of ICT services	1.6.1.	The level of control on ICT services by the ICT department. *Factors: Involvement; Scope; Overview; Catalogue.*
Domain 2. Green ICT in the organisation		
Green ICT Procurement	2.1	Whenever ICT equipment or services are procured, the environmental impact is considered. This includes Social clause (Adding sustainable criteria in clauses are always discussed and are preferably part of the purchase contract. Sustainable behavior is a critical factor when choosing a supplier (Lautenschutz et al., 2018). And product takeback practices by ICT vendors *Factors: Criteria for Energy and Material Consumption during Use; Criteria for Energy and Material Consumption during Production; Criteria for End-of-Life; Criteria weighted in TCO; Long-term Investments.*
Green ICT in Information Management and Architecture	2.2	How sustainability is considered in information management and architecture. *Factors: Monitoring Sustainability in ICT; Directives on Sustainability; Green ICT in Enterprise Architecture.*
Community collaboration	2.3	How the ICT department collaborates on sustainability issues with outside organisations. *Factors: Share Knowledge; Share Resources; Share Projects.*

Attribute		Definition
Green ICT Supply Chain Management	2.4	How the ICT department considers the environmental impact of the entire ICT supply chain in collaboration with suppliers and users. *Factors: Awareness; Optimisation.*
Green energy sources	2.5	When looking at the power consumption of IT, it is, therefore, important to not only consider this matter but also the production of energy. This factor will, therefore, be included in the model. This will be done by looking at the energy sources of the energy supplier (solar, wind, oil, coal, etc.) and the production methods.
Green data centres: planning, design and production	2.6	Identification of all Green IT initiatives in all tiers of the data centre industry. Set goals. Define a plan, approach, roadmap, timeline. Design energy efficient and environmentally sound components, computers, servers, and cooling equipment. Production is manufacture electronic components, computers and other associated subsystems with minimal or no impact on the environment (Lautenschutz et al., 2018).
Domain 3. Greening of ICT		
Housing	3.1	The resource and energy efficiency of the housing for infrastructural equipment. *Factors: Design; Energy Sources; Operation; Monitoring and Awareness.*
Computing infrastructure	3.2	The resource and energy efficiency of the computing infrastructure. *Factors: Hardware Capacity; Turn Capacity on/off; Usage of Capacity; Asset Management; Monitoring and Awareness.*
Network infrastructure	3.3	The resource and energy efficiency of the network infrastructure. *Factors: Equipment Configuration; Routing; Network Architecture; Asset Management; Monitoring and Awareness.*
Storage infrastructure	3.4	The resource and energy efficiency of the storage infrastructure. *Factors: Hardware Capacity; Data Life Cycle Management; Data Storage Optimisation; Asset Management; Monitoring and Awareness.*
End user ICT equipment (PCs, printers, etc.)	3.5	The resource and energy efficiency of end user equipment. *Factors: Equipment Provided; Power Management; Management of Secondary Resources (e.g. Toner); Monitoring and Awareness.*
Software and ICT services	3.6	The resource and energy efficiency of software applications and their development process. *Factors: Development; Configuration; Asset Management; Monitoring and Awareness.*
Green standards and metrics	3.7	These are required for promotion, comparison and benchmarking of sustainability initiatives, products, services, and practices. measure their performance and efficiency individually and furthermore to find out the overall efficiency of the data centre because it's hard to manage and measure the efficiency of the complete data centre (Lautenschutz et al., 2018)
Green IT technologies	3.8	Refers to Information Technologies and Systems for reducing the energy consumption of powering and cooling corporate IT assets, optimising the energy efficiency of the IT technical infrastructure, reducing IT induced greenhouse gas emissions, supplanting carbon emitting business practices, and analysing a business's total environmental footprint (Molla et al., 2011)
Green IT practice	3.9	Pertains to the actual application and realisation of eco-sustainability considerations in IT infrastructure sourcing, operation, and disposal (Molla, 2012)
Domain 4. Greening through ICT		
Travel reductions with ICT	4.1	ICT is used to enable travel reduction of everyone within the organisation. *Factors: Collaboration tools; Planning; Teleworking; Travel Decisions.*
Area reductions with ICT	4.2	ICT is used to enable the reduction of area use in buildings. Factors: *Individual Working Area; Collective Work Areas; Total Available Areas.*
Energy reductions with ICT	4.3	ICT is used to enable the reduction of energy consumption of the organisation. *Factors: Lighting; Heating; Power use of Non-ICT Equipment; Monitoring and Awareness.*
Paper reductions with ICT	4.4	ICT is used to enable reduction of the use of paper by digitalising business processes. *Factors: Use of Paper; Digitisation of Processes; Monitoring and Awareness.*

Attribute		Definition
Feedback and decision support	4.5	ICT is used to give the organisation detailed feedback and decision support on energy and resource consumption. *Factors: Integration of Monitoring Data; Decision Support.*
Green IS practice	4.6	Pertains to the actual application and realisation of eco-sustainability considerations in IS applications sourcing, operation and disposal
Domain 5. Greening of primary processes through ICT		
Marketing	5.1	ICT is used to enable reduction of energy and resource use in marketing processes. ICT is used to improve greening of the processes. *Process categories: Market and customer research, analyse target groups, develop pricing strategy; Design advertisement and communication strategies; Events management* (APQC, 2019)
Product development	5.2	ICT is used to enable reduction of energy and resource use in product development processes. ICT is used to improve greening of the processes. *Process categories: Manufacture the products; Product pricing / actuarial; Address legal requirements; product development and launch* (APQC, 2019)
Sales	5.3	ICT is used to enable reduction of energy and resource use in sales processes. ICT is used to improve greening of the sales processes. *Process Categories:* Acquire customers; Sell ; After sales support; Channel management. (APQC, 2019)
Underwriting	5.4	ICT is used to enable reduction of energy and resource use in underwriting processes. ICT is used to improve the greening of underwriting processes *Process Categories: Finance transactions; application handling; risk assessment/customer history; contract issue.* (APQC, 2019)
Contract administration and Customer Service	5.5	ICT is used to enable reduction of energy and resource use in contract administration. ICT is used to improve the greening of contract administration and customer service processes. *Process Categories: Change policy; Cancel policy; Call centre. Answer customer question through telephone, web based/portal, instant messaging, email services* (APQC, 2019)
Claims management	5.6	ICT is used to enable reduction of energy and resource use in claims management processes. ICT is used to improve the greening of claims processes. *Process Categories: Notice of loss, assign claim, adjudicate and investigate claim, pay claim, close / settle claim.* (APQC, 2019)
Asset and risk management	5.7	ICT is used to enable reduction of energy and resource use in asset and risk management processes. ICT is used to improve greening of the processes. *Process categories: Allocate assets; manage asset liabilities; analyse and manage all risks* (APQC, 2019)
Domain 6. E-waste management		
E=waste reuse	6.1	Reuse or refurbish of computer equipment
E-waste recycle	6.2	Dispose of in environmentally friendly ways by recycling materials and components
E-waste use as energy source	6.3	Dispose of in a manner so that the e-waste is used as a source of energy
E-waste elimination	6.4	Dispose of e-waste by burning the waste
E-waste disposal	6.5	Dispose of e-waste as waste/ garbage without any processing
Green House Gas emissions management	6.6	Minimising CO_2 emissions and wastes. Not creating harmful emissions and wastes
Radiation emissions management	6.7	Minimising radiation emissions. Not creating harmful emissions and wastes

Interview questions

Based on the model above, I will ask you the following questions during the interview. For each question, I would like you to elaborate on your answer (why you answered this way?). Since this is a semi-structured interview, there is room for follow up questions. The questions are:

Table 30. *Interview Questions*

Interview Questions
E1.1. Was the GIMMI measurement tool clear on what aspects of Green ICT maturity was being measured? If yes, what are the strong points? If not, what needs to change to make it clearer?
E1.2. Were you able to complete the GIMMi measurement tool in under 1 hour? If yes, how long did it take you? If not, what needs to change to complete the measurement in less than 1 hour?
E1.8. Is the measurement tool easy to use and is it inviting to fill out? If not, what needs to change to improve its usability?
E1.3. Do you think the GIMMI measurement tool is effective to assess green ICT maturity in your organisation? If yes, what are the strong points? If not, what needs to change to make it more effective?
E2.1. Are the presented domains sufficient? Are more domains required? Or do we need to combine any domains? Is domain 4 useful? Please provide an explanation for your responses.
E2.2. Are the attribute definitions clear and complete? If not, which attributes need to be changed? Which attributes need to be added or combined or moved to another domain? Do the attributes cover all Green IT aspects required for the insurance sector? Which attributes do not add value and can be removed?
E2.3. Is the use of a 5 maturity levels appropriate to quantify the attributes? Are the maturity level descriptions for each attribute clear and complete?
E2.4. Does every domain and attribute need to be weighed against the other domains, within domains, and if so, what are suggested weightings? Or is each domain equally weighted/important? Is each attribute within a domain equally weighted/ important?
E2.5. Is the model current? If not, what is missing or need to be changed? How does the model need to develop (over time): more or different domains, more or different attributes, other maturity levels? Will the model be usable over the next 3, 5, 10 years?
E2.6. Can you think of any other factors why is the proposed model is (not) appropriate for use in the insurance sector?
E3.1 Does the model provide a clear and complete picture of the Green ICT maturity of the organisation? If yes, what are the model's strengths? If not, what is missing or what needs to change? Or does it highlight a lack of maturity?
E3.2 Does the model provide insights in the organisation's Green ICT maturity? If yes, what are the key insights? If not, what gaps in maturity exist?
E4.1 Are the results from the GIMMI measurements clear and complete? If yes, what did you like about the results? If not, what needs to change?
E4.2 Do the results imply or trigger actions to question maturity levels, do additional research and/or help address improvement of maturity levels? If yes, which actions? If not, where is improvement required?
E4.3 Do the results highlight or imply areas for improvement to improve maturity levels? If yes, which ones stand out? If not, what is missing or how can the results be improved?

Regards, Richard Meertens

Richard.Meertens@gmail.com

Appendix 10.3. Email with Request for Feedback on Transcribed Interview

To: <Respondent first name> <Respondent last name>

From: Richard Meertens

Date: <date>

Subject: Validation of transcript of your interview

Dear <Respondent>,

Thanks again for your participation in my research. I have transcribed the interview – in yellow is (a summary of) your response. Can you please review the transcript and let me know if you approve of the transcript? Please indicate that your response was properly documented, and if not, please correct. If you want to add additional information, please go ahead.

Thanks again.

Regards, Richard Meertens

(519) 362-8293

Richard.Meertens@gmail.com

Appendix 10.4. Email with Request for Feedback on Changed Green ICT Maturity Model

To: <Respondent first name> <Respondent last name>

From: Richard Meertens

Date: <date>

Subject: Feedback on update Green ICT maturity model for the insurance sector

Dear <Respondent>,

Thanks again for your participation in my research. I have updated the Green ICT maturity model for the insurance sector based on your feedback and responses during the interviews. Below and attached, you will find the old model which I shared with you before the interview, and the updated model – changes are marked in yellow. Can you please let me know if you think the changes are appropriate, add value, and make this a more effective model for the insurance sector? Please elaborate on each of your responses.

Thanks again.

Regards, Richard Meertens

(519) 862-8293

Richard.Meertens@gmail.com

<Appendix to be developed based on interviews>

Appendix 10.5. Measurement Tool for Green ICT Maturity in the Insurance Sector

This measurement is a method of establishing your current state of Green ICT maturity. It is geared at assessing the Greening of ICT and by ICT in your company and is to be used by individuals from IT, leadership, operations, and management who are dealing with the sustainability and Greening of ICT

Table 31. *Explanation of the scoring (Curry & Donnellan, 2012):*

Score	Description	Explanation
0	No intention	Never thought about it, no awareness
1	Initial	Some awareness. Considered it, but not implemented
2	Replicable	Some ad hoc implementation, but no strategy
3	Defined	Formal programs have been defined, but implementation is immature
4	Managed	Methodical implementation of programs, with adequate measurement and management
5	Optimised	All activities are monitored and managed for optimal performance. 'Best practice'

Please provide a score for each question in the GIMMi self-measurement tool below.

Table 32. *GIMMi Measurement Tool to Measure Maturity Levels*

Attribute	Q#	Question	0 No Intention	1 Initial	2 Replicable	3 Defined	4 Managed	5 Optimised
Green Attitude	1.1	Does your company have a green attitude, meaning a set of values and norms toward climate change and eco-sustainability?						
Green Policy	1.2	Has your company put in place a Green Policy, a set of environmental criteria and frameworks put in place for the sourcing, use, and disposal of the IT technical infrastructure and the activities of IT people? Does your company have an e-waste, to reuse or recycle ICT equipment and the responsible disposal of used ICT resources? Does your company demonstrate compliance with ICT and business sustainability legislation and regulations? Does your company have policies and procedures in place describing accountability for sustainability and decision making across ICT and enterprise matters?						
People and culture	1.3	Has your company created a common language and letting people adopt sustainability in their daily business practices?						

Attribute	Q#	Question	0 No Intention	1 Initial	2 Replicable	3 Defined	4 Managed	5 Optimised
Corporate social responsibility	1.4	Has your company implemented practices to assess and address the social consequences of their activities with respect to the impact the company has on society and environment?						
Green ICT Strategy	1.5	Does your company have a green (ICT) strategy? Is your company actively executing the strategy and tracking/ communicating the progress?						
Green Governance	1.6	Does your company actively manage green (IT) initiatives: there is funding, status reporting, resources are assigned, and metrics are captured? Does your company evangelise/ communicate sustainability successes (and failures)? Does your company contribute to industry best practices for Greening of the Organisation and/or Greening of IT?						
Governance of ICT services	1.6.1	Has your company governance and internal controls in place for sustainability of ICT services?						
Domain 2: Green ICT in the organisation								
Green ICT Procurement	2.1	Does your company consider and assess the environment impact when purchasing ICT equipment or services? Does your company add social sustainability clauses to its purchase contracts? Does your company include product take back clauses to its purchase contracts? Does your company have evaluation criteria for: • *Energy and Material Consumption during Use* • *Energy and Material Consumption during Production* • *End-of-Life* When purchasing ICT equipment?						
Green ICT in Information Management and Architecture	2.2	Does your company monitor sustainability in ICT and of ICT assets? Does your company consider Green ICT when architecting and design business and ICT solutions?						
Community collaboration	2.3	Does your company and/or ICT department collaborate on sustainability issues with outside organisations?						
Green ICT Supply Chain Management	2.4	Does your company and/or ICT department consider the environmental impact of the entire ICT supply chain in collaboration with suppliers and users?						

Attribute	Q#	Question	0 No Intention	1 Initial	2 Replicable	3 Defined	4 Managed	5 Optimised
Green energy sources	2.5	Does your company the production sources of the energy consumed by the organisation, ie, the energy sources of the energy supplier (solar, wind, oil, coal, etc.) and the production methods?						
Green data centres: planning, design and production	2.6	Does your company identify, plan, and prioritise all Green IT initiatives? Does your company design for energy efficient and environmentally sound components, computers, servers, and cooling equipment? Does your company consider how ICT equipment is manufactured in a sustainable manner with minimal or no impact on the environment?						
Domain 3: Greening of ICT								
Housing	3.1	Does your company consider the resource and energy efficiency of the housing for ICT infrastructural equipment, i.e., the data centre?						
Computing infrastructure	3.2	Does your company consider the resource and energy efficiency of the computing infrastructure: Hardware Capacity; Turn Capacity on/off; Usage of Capacity?						
Network infrastructure	3.3	Does your company consider the resource and energy efficiency of the network infrastructure?						
Storage infrastructure	3.4	Does your company consider the resource and energy efficiency of the storage infrastructure?						
End user ICT equipment (PCs, printers, etc.)	3.5	Does your company consider the resource and energy efficiency of end user equipment – laptops, monitors, printers, cell phones?						
Software and ICT services	3.6	Does your company consider the resource and energy efficiency of software applications and their development process?						
Green standards and metrics	3.7	Does your company have green standards and metrics to promote, compare and benchmark sustainability initiatives, products, services, and practices? Does your company measure their performance and efficiency individually and furthermore to find out the overall efficiency of the data centre?						
Green IT technologies	3.8	Does your company employ Information Technologies and Systems for reducing the energy consumption of powering and cooling corporate IT assets, optimising the energy efficiency of the IT technical infrastructure, reducing IT induced greenhouse gas emissions, supplanting carbon emitting business practices, and analysing a business‘s total environmental footprint?						
Green IT practice	3.9	Does your company consider the actual application and realisation of eco-sustainability considerations in IT infrastructure sourcing, operations, and disposal?						
Domain 4: Greening through ICT								

Attribute	Q#	Question	0 No Intention	1 Initial	2 Replicable	3 Defined	4 Managed	5 Optimised
Travel reductions with ICT	4.1	Does your company use ICT is used to enable travel reduction of everyone within the organisation? Does your company consider the environment when making Travel Decisions?						
Area reductions with ICT	4.2	Does your company use ICT to reduce area use in buildings? Does your company allow Teleworking?						
Energy reductions with ICT	4.3	Does your company use ICT to reduce energy consumption of the organisation? (lighting, heating, equipment on/off)						
Paper reductions with ICT	4.4	Does your company use ICT to reduce the use of paper by digitalising business processes?						
Feedback and decision support	4.5	Does your company use ICT to give the organisation detailed feedback and decision support on energy and resource consumption?						
Domain 5: Greening of primary processes through ICT								
Marketing	5.1	Does your company use IT to enable reduction of energy and resource use in Market and customer research business process and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use in the Analyse Target Groups business process and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use in the Develop Pricing strategy business process and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when designing advertising and communication strategies and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when holding events and/or improve the greening of this process?						
Product development	5.2	Does your company use IT to enable reduction of energy and resource use when manufacturing products and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when pricing products and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when addressing legal issues and/or improve the greening of this process?						

Attribute	Q#	Question	0 No Intention	1 Initial	2 Replicable	3 Defined	4 Managed	5 Optimised
		Does your company use IT to enable reduction of energy and resource use when developing and launching new products and/or improve the greening of this process?						
Sales	5.3	Does your company use IT to enable reduction of energy and resource use when acquiring customers nd/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when selling products and services and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when providing after sales support and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when managing sales and distribution channels, and/or improve the greening of this process?						
Underwriting	5.4	Does your company use IT to enable reduction of energy and resource use when processing financial transactions and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when handling applications and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when assessing risks and reviewing customer history and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when issuing the insurance contracts and/or improve the greening of this process?						
Contract administration and Customer Service	5.5	Does your company use IT to enable reduction of energy and resource use when changing insurance policy information and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when cancelling insurance policies and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when answering questions from customer in the call centre, by telephone, portal, instant messaging, or email and/or improve the greening of this process?						
Claims management	5.6	Does your company use IT to enable reduction of energy and resource use when processing a notice of claim loss and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when adjudicating and investigating a claim and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when paying a claim and/or improve the greening of this process?						

Attribute	Q#	Question	0 No Intention	1 Initial	2 Replicable	3 Defined	4 Managed	5 Optimised
		Does your company use IT to enable reduction of energy and resource use when closing or settling a claim and/or improve the greening of this process?						
Asset and risk management	5.7	Does your company use IT to enable reduction of energy and resource use when allocating and procuring assets and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when managing asset liabilities and/or improve the greening of this process? Does your company use IT to enable reduction of energy and resource use when analysing and managing all risks and/or improve the greening of this process?						
Domain 6: E-waste management								
E=waste reuse	6.1	Does your company reuse or refurbish computer equipment?						
E-waste recycle	6.2	Does your company dispose of ICT and other assets in an environmentally friendly way by recycling materials and components?						
E-waste use as energy source	6.3	Does your company dispose of ICT and other assets by using the e-waste as an energy source?						
E-waste elimination	6.4	Does your company dispose of ICT and other assets by burning it?						
E-waste disposal	6.5	Does your company dispose of ICT and other assets by dumping it in the garbage?						
Green House Gas emissions management	6.6	Does your company manage green house gas emissions of its ICT assets and business processes? Does your company consider not creating harmful emissions and wastes?						
Radiation emissions management	6.7	Does your company manage radiation emissions of its ICT assets? Does your company consider not creating harmful emissions and wastes?						

Appendix 11. Key Points from Interviews with Respondents

This is a summary of the key points, extracted from the interview transcripts with the 6 respondents. In yellow is information that is relevant to the research results. In green is information that could be cited in the thesis report.

Table 33. *Key points from Six Respondents' Interviews*

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E1.1. Clear measurement tool	Yes, but not all aspects are clear. Two assessment tools this one and a more detailed one	Yes. Not aware of legislation and compliance for sustainability. No communication on our company's sustainability policy	Yes, models are great with categorisation and boundaries.	Yes, categories clear - it's strategy focused, core operations focused. Some of the questions/ wording not clear, may lead to different answers depending on how interpret question: is green motivator or cost savings motivator or both in answering questions	Yes, points were made see below	Yes - Got me thinking what we should be thinking about – like having an overarching strategy, guidelines, and having corporate wide measures.	Strong tool with good categories and boundaries.
E1.2. Time to complete tool	40 minutes	45 minutes	30 minutes, more if we had better scores	40 minutes Suggest providing context for this model and each domain and set the tone for the assessment/ why am I answering these questions. Suggest not use 'greening' but 'environmental or green IT impact'.	30 minutes, but 90 minutes for full prep Suggest not having default value	50 minutes	30-50 minutes

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E1.3. Tool easy to use	Yes	Yes, straight forward	Yes, use colours to break it up and make more inviting - same colours in model and tool.	Yes. Web-based would be better. Add a comments/ notes column to give respondent opportunity to add flavour/ context for their answers.	Yes	Yes, thought provoking. Web-based would be better. Add a comments/ notes column to give respondent opportunity to add flavour/ context for their answers.	Make it easier to use by using colours across tool and model; make it web-based; provide context for each domain
E1.4. Tool effective to assess maturity	Yes. IT would be key enabler for this green strategy.	Yes, strong point is breakout into domains so you can look at it from multiple angles	Yes. Domain 1 familiar. Others not as familiar. No assessment of occupational disease and IT being done - not clear in this model.	Yes. Many questions lack context for a non-IT leader, I do not know some of the IT answers.	Yes, going through questions more valuable than results page	Yes. Green is usually secondary driver for systems project - cost saving is #1	Categories make it effective to assess maturity in each domain. Individual attributes give a better indication of maturity than at domain level. Green is secondary driver for becoming more mature - cost savings is key driver.
E2.1. Domains sufficient	Yes, impact on, align with, rethink purpose of organisation with green ICT being new driver of products and services	Yes, sparks good thinking about green ICT	Yes, better labels of domains 3, 4, and 5 - they are crux of the model. Clearer on use of IT with respect to domains	Yes.	Yes, very strong model	Yes. Missing may be HR, Finance/ Accounting. Facilities	Strong model with good categorisation in domains. Labelling/ description needs to be improved
E2.2. Attribute definitions clear and complete	Yes, works well for insurance sector	Yes	Yes, missing are digital platforms/ channel management / distribution communication channels - how business is done - increases how IT is being used	Yes. Changes suggested see below	Yes. Network infrastructure and computing could be combined. Practice items seem redundant. Term 'manufacture' seems out of place.	Yes.	Clear attribute descriptions that work well for insurance sector. Suggestions for change are digital platforms/ channel management, combining technical items in domain 3, adding finance, HR, facilities.

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E2.3. 5 maturity levels appropriate	Yes, 1-5. Level 0 not required	Yes, 0-5 + N/A	Yes but less levels would be easier	Yes. Suggest 'I don't know' option. Suggest 4 or 6 scale so no option in middle. Suggest combining 0 and 1 to 1. Suggest taking numbers out - just use the descriptions. Change option 2 to ad-hoc.	Yes. Suggest 'I don't know' option. Value 2 and 3 do not seem different Driving force is not green, but cost savings. Doing the right thing is key - if green is an outcome of that, so the better	Yes	0-5 maturity levels are good since aligned with CMMI which is widely used. Change descriptions of 2 and 3, delete level 0 and provide a 'not applicable' value.
E2.4. Weighting of domain and attribute	Equal. Apply weighting for actions/ priorities	Equal. Apply weighting for actions/ priorities	Equal. Apply weighting for actions/ priorities. Domain 1 and 6 heavier weighted. Start with Domain 1. Weighting is not important for assessment but for priority to act. Add columns for skill and priority to help with action planning	Equal. Apply weighting for actions/ priorities, importance to the organisation Overlay target maturity levels so you see what the gap is Add columns for skill and priority to help with action planning	Equal. Apply weighting for actions/ priorities	Equal. Apply weighting for actions/ priorities. Some domains provide bigger bang for the buck.	Equal weighting for the assessment is good. In future assessment with same company, weighting can be applied based on senior management direction. For action planning, weighting will help with setting priorities.
E2.5. Model current	Yes, more content around cloud and digital transformation. Some terminology can be modernised or use terms used in insurance sector. Domains will be usable for 5-10 years, but attributes will evolve over time as trends, hot topics in IT and insurance change. Revamp in 5 years	Yes, how the model might change depends on policy and strategy AI can change how business processes work, which can make it greener. Current for 3-5 years, probably need to redo for 10 years horizon	Yes, but will need to be finetuned over time. As with any model, you need to start somewhere and iterate over time.	Yes, cloud is missing - needs to be more pervasive in tool - in 5 years most will be cloud, but will it be greener overall. Sources of energy likely are not know to the organisation. Need to incorporate use of carbon offsets - but can a company be carbon neutral.	Yes. Assessment is only one step in the process - is there an overall process Cloud needs to be incorporated - how do we assess ourselves in cloud era. Domains are generic enough that they will not really change over time. This model and measurement tool to be ingrained in regular business processes such as cost benefit analysis and business planning.	Yes. Cloud needs to be incorporated - how do we assess ourselves in cloud era.	In general model is current but need to be enhanced with Cloud, digital transformation, AI, carbon offsets, more modern and insurance appropriate terminology. Model is good for 5 years and will need revamping after that.

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E2.6. Other factors why model is (not) appropriate for use in insurance	Model will not for independent brokers - green not important to them. Measurement tool can become insurance's benchmark tool. Green ICT maturity will become critical for the insurance sector over next 10 years.	No other factors. Model can apply to any industry	It is clear on who owns what in this and each domain. Cherry-picking (several items in each domain or just one domain) will not work. You will leave a whole lot of opportunity if you do not action the whole model	As a business user, do I care to be green - with cloud SaaS it's the solution and $$ that count, not if it is green - question is do externalities become part of an organisation's green footprint.	Insurance sector has an opportunity to be very green - it deals in data. Just need to watch out for doing things in a way that are not green.	Younger people value companies that are greener or work on becoming greener. Will get frustrated if not green. Some financial services legislation works against becoming greener	Green ICT maturity is impacted by external parties such as brokers and independent sales agents, and clients, who may not be able or willing to participate in green initiatives or processes. Younger people will have an expectation to work with insurance companies that actively work on becoming greener through ICT. Some financial services legislation works against becoming greener
E3.1 Clear and complete picture of the Green ICT maturity	Yes, use with Board of Directors to communicate where we are and where we need to change, focus	Yes, suggest colour coding to highlight the areas in the model to focus on	Yes, broad, and clear. Executive buy-in is key - no executive will stall progress. If you start with domain 3, 4, 5 it will be grass roots. Starting with Domain 1 will increase overall success. Green is not the driver it's productivity and cost savings.	Yes. But is it important or does It matter - more important is that an organisation is intent on improving and really move the dial on improving the environment and what is the value on getting to our target?	Yes.	Yes. IT helps highlight lack of green maturity	Provides clear and complete picture of current Green ICT maturity of an organisation. It highlights where green ICT is lacking. But does it matter - more important that there is an intent and call to action to improve.

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E3.2 Model provide insights in maturity	Yes, tool provides current reading of the organisation. Depending on where the organisation is in the journey, you may put more weighting on domain 1.	Yes, big takeaway is that my company places no emphasis or importance on Green ICT - profitability is #1 focus. Tool points out the bad things we already know about. Actions depend on who is setting the priorities for greening - no body right now	Yes, but no governance in place to support any actions or make decisions. Does moving to the cloud really reduce carbon footprint or just displace it to somewhere else?	Yes, it raised my awareness on improving/ greening business processes and to use IT to do it - domain 4 raised awareness on green impact	Yes. Insight is that green is not part of most or all of our processes, policies, system dev life cycle. Insights in each domain where I can make an impact - what have we done recently that is good for the environment. It's about communication - but not within IT and not ingrained in culture and processes	Yes. Highlights opportunities for improvement. Greening needs to be built into the project management methodology	Provides insights where you are strong and weak, where you need to focus based on your score/ if weak in domain 1. It also provides insight in the fact if a company does not place any importance on green maturity, that no governance and no decision making process is in place, that greening is not part of most business processes, policies and systems and project methodologies
E4.1 Results clear	Yes	Yes, results raise awareness of the opportunities - the areas you can impact - and the fact that these opportunities are not even being considered.	Yes, add pie charts - how much is left to be done. And some other views. Suggest to tier/ graph the results (by domain). Our poor results really do not help with any insights - pointing out the obvious. But sometimes you need to point out the obvious. Low scores of an attribute can skew the score of a domain - highlight within a domain where the scores are low or high	Yes, radar map gives good picture. For action, helpful to see which domains are most impactful on the environment - where to start, where to focus Lacking putting the results in context - is our organisation weak or strong in the right domains; do our results predict where we need to focus	Yes. Results so high level not sure what it tells you. Stronger in some domains, weaker in others - more valuable to go through the questions and thinking about those. Results were not surprising; tell me that we don't think about this, but we are better than we thought; we are not doing this in a planned way	Yes, relative score to other companies would be useful. Need to do this every one or two years - unbiased view on progress.	Results (radar graph) are clear but limited: highlight the obvious, more perspectives require such as by domain, pie chart (what is left). Useful to put the results in context for example by comparing to other organisations or comparing to insights from other companies. Also, this assessment needs to be done every one or two years to show progress.

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E4.2 Results imply or trigger actions	Yes	Yes, what needs to change first is a reason why a company needs to adopt a green ICT policy.	Yes. With poor scores like ours it is difficult to discuss. Sometimes you do not need to go deep in results analysis - are you doing it yes or no. Yes, implying specific actions for me personally.	Yes, imply yes. Trigger depends on the intent why the assessment was done	Yes. We need to make this part of our business case, our methodology. Where we scored lower, those are areas for action	Yes, some domains higher priority - low score would help in defining action plan	Results imply actions but triggering of actions depends on the intent of senior management, alignment with strategy and public image.
E4.3 Results highlight or imply areas for improvement	No, tool is weak on this - what do I do and why do I care to make improvements. Yes, it told me that overall, we are not mature, do not have the level of maturity we should have. We have some level of maturity in domain 3 and 4. Green ICT was not strategically driven, more operational efficiency and cost savings. Results do not show how to get where we need to be and when - need to get the indicators/ direction to get to the next level(s) into the model - specific actions will be different for every company	Yes, starting with getting the attention of senior management to adopt Domain 1 - strategy and policy for sustainability	Yes. But grassroots right now - no strategy, no mandate to do any of this.	Yes	Yes. More categorisation and dimensions of the results.	Yes, a green policy is important first step - then show commitment. Good step towards internal engagement - identify initiatives based on this. Make it part of performance management.	Areas of improvement are not clearly laid out in the model, but the model can be helpful in coming up with opportunities for improvement.

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
E.1. Measurement tool	Need to clearly delineate domains. Online tool would be more user friendly with one page for each domain starting with a context description. Keep 0-5 on screen all the time. Rephrase questions as statements - seems to be best practice			Need to clearly delineate domains. Online tool would be more user friendly with one page for each domain starting with a context description. Keep 0-5 on screen all the time	Sometimes it is not clear in the questions if you are talking about IT or the organisation. Online tool would be more user friendly with one page for each domain starting with a context description. Keep 0-5 on screen all the time. Sometimes it is not clear in the questions if you are talking about IT or the organisation.		The tool and model need to be clear on if it relates to IT or to the organisation for each attribute and domain. Online tools will improve the ease of use of the tool.
E.2. Model	Need to clearly delineate domains - add context descriptions for each domain.		domains 3, 4, and 5 - they are crux of the model. Clearer on use of IT with respect to domains	For domain 2 and 3 sometimes felt answering the same question. Suggest carving questions in two - are you green and are you (planning on) improving it, do you have momentum to get to where you want to go (including strategic intent and organisation capability)	1st, 2nd, and 3rd order need to be better explained		Provide better and clear context for assessment, model, and tool - delineate domains clearly

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
Domain 1	Rethink purpose, philosophy, and posture for sustainability of organisation with green ICT being driver of new and improved products and services; and being a sustainable company. Good starting point - the WHY - will drive the how and what of other domains	Domain 1 would be focus for action for our company. Legislation and compliance for sustainability could be clearer in model	Subitems can be deleted or better clarity why they are there (and no other subitems).	Separate social impact/ corporate responsibility or environmental impact - you can be socially responsible but not green For Domain 1 you need to understand the organisation's intent- their stated intention for being green	Subitems can be deleted or better clarity why they are there (and no other subitems).	organisation should have an overarching 'green' strategy/ why it is important, guidelines, corporate wide measures, and plans to get engagements to make this happen. Green criteria not part of procurement	Domain 1 is critical to have higher maturity to ensure higher maturity in the other domains. A corporate green strategy and policy will be key. Areas for clarification include distinguishing social responsibility and green/ environmental; incorporating rethinking of purpose and posture of the company to become more sustainable; addressing legislation and compliance factors
Domain 2	Needs to be crisper delineation		When procuring IT, you do not really consider the green impact. You would assume it is part of the procurement process, but it is not. Newer technology does not mean it is greener and safer.	crisp questions so easier to answer in this domain the word manufacture in insurance context does not work			The word 'manufacture' is not used for insurance products and services.
Domain 3				Better to respond by an IT person 3.3 and 3.4 feel like the same		Technology items can be combined	Technology items can be combined

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
Domain 4	Other indirect perspective: Productivity improvement leads to headcount gains leads to lower use of paper, travel. Hard savings of space, travel, less paper, also soft savings of better people engagement and productivity	We do travel related well - but more cost driven than green.		Struggled with wording - find a way to say deploy IT to be more environmentally conscious	About IT and Business Facilities management required		Facilities management (buildings, heating systems) can be added or separated from the IT related items. Attributes drive efficiencies but other productivity improvements can drive more efficient attributes.
Domain 5	Too many questions: One or two questions per aspect of Domain 5 would be better. Some of the questions can be combined or deleted	7 areas are important, but I cannot talk to them, not at my level, exec would be more suited to answer these	Not all applicable to our organisation - maybe just administration. missing are digital platforms/ channel management / distribution communication channels - how business is done - increases how IT is being used Legal is missing - legal implications are a core capability	Not sure if there are green opportunities Phrasing of Domain 5 questions - should be more around green impact. It is not about energy savings Can we trigger activities within our broader value chain (with external partners, clients), maybe by providing green products, services, incentives?	Just about business	Key area	Domain 5 attributes need more clarity.
Domain 6	For our organisation, for domain 6, we did have an e-waste program that covers 6.1, 6.2 and 6.3 but did not consider 6.4 and 6.5 at all. Good to get these kinds of insights.			crisp questions so easier to answer in this domain Some questions 6.3 reversed If a green process means an inferior process, than green is not a good thing.	6.3 reversed	6.3 reversed	Domain 6 has some wording issues that need to be addressed.

Interview Questions	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Overall
Overall	Tool provides a lens that I have not look through Smaller organisations might be able to lead this as they can be more agile. Larger organisations might be too big to consider these improvements.	Senior management needs to start driving this.	Executive buy-in is key - no executive will stall progress. If you start with domain 3, 4, 5 it will be grass root. Starting with Domain 1 will increase overall success. Model is very good - good that you are trying to make it valuable and useful		Our company is proud of its sustainability efforts - but you do not see come through in IT		Senior management needs to buy-in to improving green ICT maturity and then drive the priorities every year.

Appendix 12. Maturity Ranking by Model Attribute (low to high)

Appendix 12 has four tables:

- Table 34 Highest and lowest maturity by model attributes. This table has all the model attributes and the highest and lowest maturity attributes for the insurance sector, and the P&C and Life subsectors are indicated. The table shows that:
    - Domain 1 – Green Strategy and Policy - has some of the lowest maturity ratings for the P&C Insurance sector and some of the highest for the Life Insurance sector
    - Domain 2 – Green ICT in the organisation - has some of the lowest ratings for both the P&C and Life insurance sectors
    - Domain 3 – Greening of ICT – has moderate ratings for both the P&C and Life insurance sectors
    - Domain 4 – Greening through ICT – has high ratings for both the P&C and Life insurance sectors, for most attributes
    - Domain 5 - Greening of primary processes through ICT – has low ratings for both the P&C and Life insurance sectors, for most attributes
    - Domain 6 – e-Waste management – has high ratings for the reuse and recycle attributes for both the P&C and Life insurance sectors, for most attributes
- Table 35 Model attributes with highest and lowest maturity for insurance sector. This table lists the model attributes with the highest and lowest maturity scores attribute for the insurance sector.
    - The highest maturity ratings occur for Domain 4 and 6 model attributes.
- Table 36 Model attributes with highest and lowest maturity for P&C insurance sector. This table lists the model attributes with the highest and lowest maturity scores attributes for the P&C insurance sector.
    - The highest maturity ratings occur for Domain 4 and 6 model attributes.
    - The lower ratings occur for Domain 1 and 2.
- Table 37 Model attributes with highest and lowest maturity for Life insurance sector. This table lists the model attributes with the highest and lowest maturity scores attributes for the Life insurance sector.
    - The higher ratings occur for Domain 1 plus individual attributes from other Domains.
    - Lower ratings for Domain 2 and 6 plus individual attributes from other Domains.

Legend
Highest Maturity
Lowest Maturity

Table 34. *Highest and Lowest Maturity Score for Six Respondents by Model Attribute*

Model Attribute	#	Average (all respondents)	Average P&C (Respondents 1-4)	Average Life (Respondents 5-6)
Domain 1: Green ICT Strategy and Policy				

Model Attribute	#	Average (all respondents)	Average P&C (Respondents 1-4)	Average Life (Respondents 5-6)
Green Attitude	1.1	1.67	1.00	3.00
Green Policy	1.2	1.42	0.94	2.38
People and culture	1.3	1.17	0.25	3.00
Corporate social responsibility	1.4	1.67	1.00	3.00
Green ICT Strategy	1.5	0.67	0.00	2.00
Green Governance	1.6	0.83	0.15	2.20
Governance of ICT services	1.6.1	0.67	0.00	2.00
Domain 2: Green ICT in the organisation				
Green ICT Procurement	2.1	1.19	1.04	1.50
Green ICT in Information Management and Architecture	2.2	0.83	0.50	1.50
Community collaboration	2.3	1.17	0.25	3.00
Green ICT Supply Chain Management	2.4	0.33	0.00	1.00
Green energy sources	2.5	0.50	0.00	1.50
Green data centres: planning, design and production	2.6	0.94	0.42	2.00
Domain 3: Greening of ICT				
Housing	3.1	1.83	1.00	3.50
Computing infrastructure	3.2	1.33	0.75	2.50
Network infrastructure	3.3	1.33	1.00	2.00
Storage infrastructure	3.4	1.33	1.00	2.00
End user ICT equipment (PCs, printers, etc.)	3.5	1.17	0.50	2.50
Software and ICT services	3.6	0.67	0.75	0.50
Green standards and metrics	3.7	0.83	0.25	2.00
Green IT technologies	3.8	1.00	0.50	2.00
Green IT practice	3.9	1.00	0.50	2.00

Model Attribute	#	Average (all respondents)	Average P&C (Respondents 1-4)	Average Life (Respondents 5-6)
Domain 4: Greening through ICT				
Travel reductions with ICT	4.1	1.83	1.38	2.75
Area reductions with ICT	4.2	2.08	1.88	2.50
Energy reductions with ICT	4.3	2.00	1.50	3.00
Paper reductions with ICT	4.4	2.50	2.50	2.50
Feedback and decision support	4.5	1.33	1.00	2.00
Domain 5: Greening of primary processes through ICT				
Marketing	5.1	0.70	0.10	1.90
Product development	5.2	0.67	0.00	2.00
Sales	5.3	0.88	0.25	2.13
Underwriting	5.4	1.21	0.38	2.88
Contract administration and Customer Service	5.5	1.11	0.33	2.67
Claims management	5.6	1.38	0.50	3.13
Asset and risk management	5.7	0.83	0.00	2.50
Domain 6: E-waste management				
E-waste reuse	6.1	2.33	2.25	2.50
E-waste recycle	6.2	3.17	3.00	3.50
E-waste disposal	6.3	0.50	0.50	0.50
Green House Gas emissions management	6.4	1.33	1.00	2.00
Radiation emissions management	6.5	0.75	0.38	1.50

Table 35. *Highest and Lowest Maturity Attributes for Insurance Sector-Six Respondents*

Average (all respondents)	#	Average (all respondents)
E-waste recycle	6.2	3.17
Paper reductions with ICT	4.4	2.50
E=waste reuse	6.1	2.33
Area reductions with ICT	4.2	2.08
Energy reductions with ICT	4.3	2.00
Travel reductions with ICT	4.1	1.83
Green ICT Strategy	1.5	0.67
Governance of ICT services	1.6.1	0.67
Software and ICT services	3.6	0.67
Product development	5.2	0.67
Green energy sources	2.5	0.50
E-waste disposal	6.3	0.50
Green ICT Supply Chain Management	2.4	0.33

Table 36. *Highest and Lowest Maturity Attributes-P&C insurance sector-Four Respondents*

Average P&C (Respondents 1-4)	#	Average P&C (Respondents 1-4)
E-waste recycle	6.2	3.00
Paper reductions with ICT	4.4	2.50
E=waste reuse	6.1	2.25
Area reductions with ICT	4.2	1.88
Energy reductions with ICT	4.3	1.50
Green Governance	1.6	0.15
Marketing	5.1	0.10
Green ICT Strategy	1.5	0.00

Average P&C (Respondents 1-4)	#	Average P&C (Respondents 1-4)
Governance of ICT services	1.6.1	0.00
Green ICT Supply Chain Management	2.4	0.00
Green energy sources	2.5	0.00
Product development	5.2	0.00
Asset and risk management	5.7	0.00

Table 37. *Highest and Lowest Maturity Attributes-Life insurance sector-Two Respondents*

Average Life (Respondents 5-6)	#	Average Life (Respondents 5-6)
Housing	3.1	3.50
E-waste recycle	6.2	3.50
Claims management	5.6	3.13
Green Attitude	1.1	3.00
People and culture	1.3	3.00
Corporate social responsibility	1.4	3.00
Community collaboration	2.3	3.00
Energy reductions with ICT	4.3	3.00
Green ICT Procurement	2.1	1.50
Green ICT in Information Management and Architecture	2.2	1.50
Radiation emissions management	6.5	1.50
Green energy sources	2.5	1.50
Green ICT Supply Chain Management	2.4	1.00
Software and ICT services	3.6	0.50
E-waste disposal	6.3	0.50

Appendix 13. Updated GIMMi

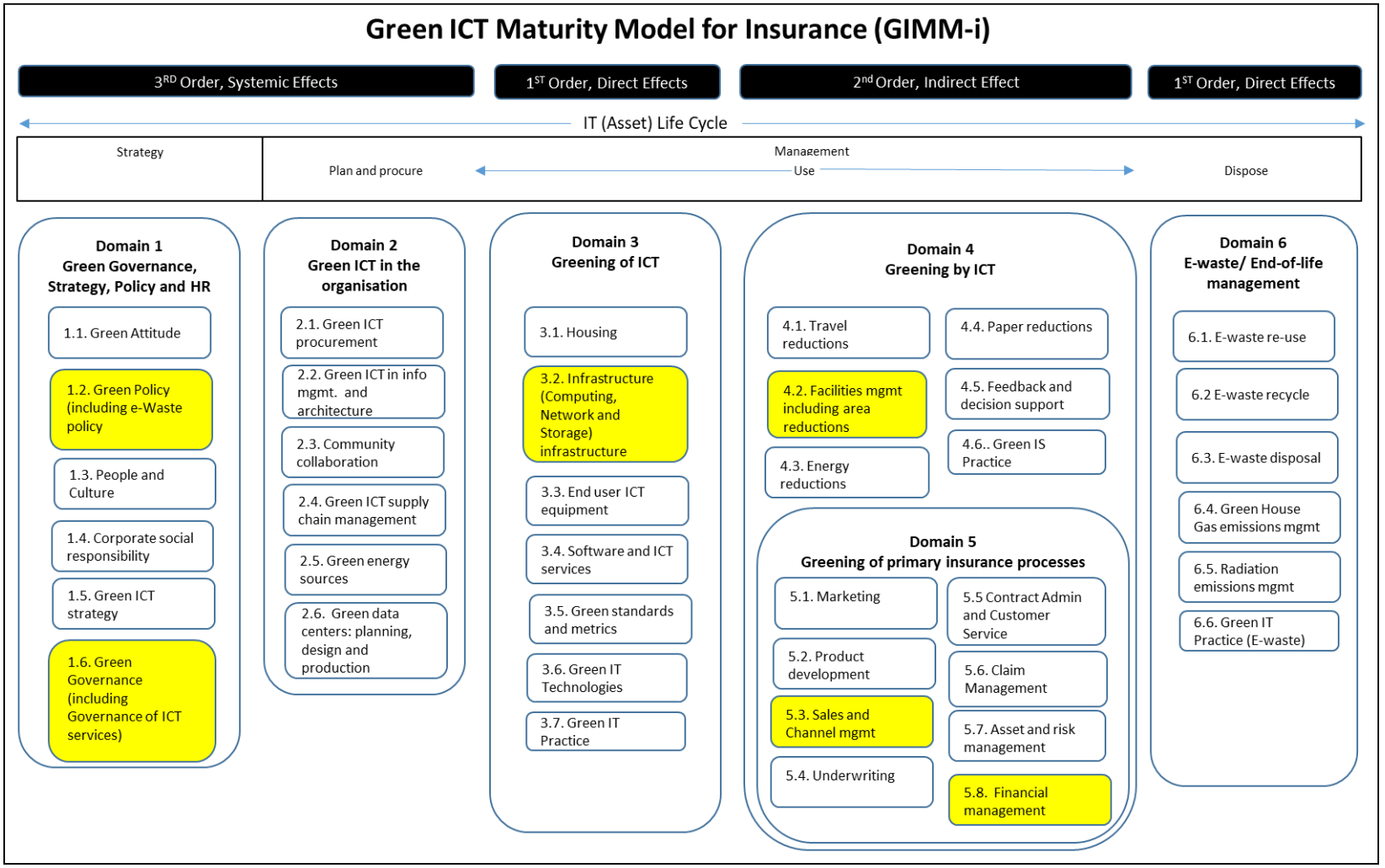

Figure 17. Updated GIMMi model

Appendix 14. Updated GIMMi Measurement Tool

Table 38. *Updated GIMMi Measurement Tool*

Model attribute	Ref #	Question / Clarification	Maturity Score
Domain 1: Green Strategy and Policy - Relates to the sustainability of the organisation including strategy, policy, processes, people, culture, and governance.			
Green Attitude	1.1	Does your company have a green attitude, meaning a set of values and norms toward climate change and eco-sustainability?	1 - Initial
Green Policy	1.2	Has your company put in place a green IT policy, a set of environmental criteria and frameworks for the sourcing, use, and disposal of the IT technical infrastructure and the activities of IT people and vendors?	1 - Initial
		Does your company have an e-waste policy, to reuse or recycle ICT equipment and the responsible disposal of used ICT resources?	1 - Initial
		Does your company demonstrate compliance with ICT and business sustainability legislation and regulations?	1 - Initial
		Does your company have policies and procedures in place describing accountability for sustainability and decision making across the organisation for ICT and enterprise matters?	1 - Initial
People and culture	1.3	Has your company created a common language for greening of the organisation and adoption of sustainability in daily business practices?	1 - Initial
Corporate social responsibility	1.4	With respect to the impact the company has on society and environment, has your company implemented practices to assess and address the social consequences of their activities?	1 - Initial
Green ICT Strategy	1.5	Does your company have a green (ICT) strategy?	1 - Initial
		Is your company actively executing the green strategy and tracking and communicating the progress?	1 - Initial
Green Governance	1.6	Does your company actively manage green (IT) initiatives: there is funding, status reporting, resources are assigned, and metrics and benefits are tracked and communicated?	1 - Initial
		Does your company evangelise and/or communicate sustainability successes (and failures), internally and externally?	1 - Initial
		Does your company contribute to industry best practices for greening of the organisation and/or Greening of IT?	1 - Initial
		Has your company governance and internal controls in place for sustainability of ICT services?	1 - Initial
Domain 2: Green ICT in the organisation - Relates to IT sustainability. IT specific Items in addition to Domain 1 attributes.			
Green ICT Procurement	2.1	Does your company consider and assess the environmental impact when purchasing ICT equipment or services?	1 - Initial
		Does your company add social sustainability clauses to its purchase contracts?	1 - Initial
		Does your company include product take back clauses to its purchase contracts?	1 - Initial
		Does your company have evaluation criteria for	

Model attribute	Ref #	Question / Clarification	Maturity Score
		· Energy and Material Consumption during Use;	1 - Initial
		· Energy and Material Consumption during Production;	1 - Initial
		· End-of-Life reuse or disposal	1 - Initial
		· Green IT when purchasing ICT equipment?	1 - Initial
Green ICT in Information Management and Architecture	2.2	Does your company monitor sustainability in ICT and of ICT assets?	1 - Initial
		Does your company consider Green ICT when architecting and designing business and ICT solutions?	1 - Initial
Community collaboration	2.3	Does your company and/or ICT department collaborate on sustainability issues with outside organisations?	1 - Initial
Green ICT Supply Chain Management	2.4	Does your company and/or ICT department consider the environmental impact of the entire ICT supply chain in collaboration with suppliers and users?	1 - Initial
Green energy sources	2.5	Does your company assess and track the energy/power production sources consumed by the organisation, i.e., the energy sources of the energy supplier (solar, wind, oil, coal, etc.) and the production methods?	1 - Initial
Green data centres: planning, design and production	2.6	Does your company identify, plan, and prioritise all Green IT initiatives for their data centres and cloud environments?	1 - Initial
		Does your company design for energy efficient and environmentally sound components, computers, servers and cooling equipment and/or require their cloud providers to do so?	1 - Initial
		Does your company consider how ICT equipment is manufactured in a sustainable manner with minimal or no impact on the environment?	1 - Initial
Domain 3: Greening of ICT - Relates to IT technologies such computing equipment and infrastructure			
Housing	3.1	Does your company consider the resource and energy efficiency of the housing for ICT infrastructural equipment, i.e., the data centre, on-site or at a vendor location?	1 - Initial
Infrastructure (network, computing, storage)	3.2	Does your company consider the resource and energy efficiency of the infrastructure: hardware capacity; turn capacity on/off; efficient usage of capacity infrastructure?	1 - Initial
End user ICT equipment (PCs, printers, etc.)	3.3	Does your company consider the resource and energy efficiency of end user equipment – laptops, monitors, printers, cell phones, etc.?	1 - Initial
Software and ICT services	3.4	Does your company consider the resource and energy efficiency of software applications and their development process?	1 - Initial

Model attribute	Ref #	Question / Clarification	Maturity Score
Green standards and metrics	3.5	Does your company have green standards and metrics to promote, compare and benchmark sustainability initiatives, products, services and practices?	1 - Initial
		Does your company measure their performance and efficiency of Greening of IT and business processes and measure the overall efficiency of the data centre?	1 - Initial
Green IT technologies	3.6	Does your company employ technologies and systems for reducing the energy consumption of powering and cooling corporate IT assets, optimising the energy efficiency of the IT technical infrastructure, reducing IT induced greenhouse gas emissions, supplanting carbon emitting business practices, and analysing the organisation's total environmental footprint?	1 - Initial
Green IT practice	3.7	Does your company consider the application and realisation of eco-sustainability factors in IT infrastructure sourcing, operation and disposal?	1 - Initial
Domain 4: Greening through ICT - Relates to business processes that can be made more sustainable/ greener using ICT			
Travel reductions with ICT	4.1	Does your company use ICT to enable travel reduction within the organisation and of vendors and business partners?	1 - Initial
		Does your company consider the environment when making travel decisions?	1 - Initial
Facilities management including Area reductions with ICT	4.2	Does your company use ICT to reduce area use in buildings?	1 - Initial
		Does your company allow working from home/ teleworking?	1 - Initial
Energy reductions with ICT	4.3	Does your company use ICT to reduce energy consumption of the organisation (lighting, heating, equipment on/off)?	1 - Initial
Paper reductions with ICT	4.4	Does your company use ICT to reduce the use of paper by digitalising business processes?	1 - Initial
Feedback and decision support	4.5	Does your company use ICT to give the organisation detailed feedback and decision support on energy and resource consumption?	1 - Initial
Domain 5: Greening of primary processes through ICT - Relates to the primary business processes of an insurance company and if they can be made more sustainable/ greener using ICT			
Marketing	5.1	When doing market and customer research, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When analyse target customer groups, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When developing a pricing strategy for products and services, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial

Model attribute	Ref #	Question / Clarification	Maturity Score
		When designing advertising and communication strategies, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When holding events for customers and business partners, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Product development	5.2	When manufacturing products, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When pricing products, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When addressing legal issues, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		Does your company use IT to enable reduction of energy and resource use when developing and launching new products and/or improve the greening of this process?	1 - Initial
Sales and Channel management	5.3	When acquiring new customers and business partners, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When selling products and services, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When providing after sales support, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When managing sales and distribution channels, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Underwriting	5.4	When processing financial transactions, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When handling insurance applications, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When assessing risks and reviewing customer history, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When issuing insurance contracts, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Contract administration and Customer Service	5.5	When changing insurance policy information, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When cancelling insurance policies, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial

Model attribute	Ref #	Question / Clarification	Maturity Score
		When answering questions from customer in the call centre, by telephone, portal, instant messaging or email, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Claims management	5.6	When processing a notice of claim loss, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When adjudicating and investigating a claim, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When paying a claim, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When closing or settling a claim, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Asset and risk management	5.7	When allocating and procuring assets, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When managing asset liabilities, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
		When analysing and managing all risks, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Finance and accounting	5.8	When accounting and managing finance, does your company use IT to reduce energy and resource use and be more sustainable and greener?	1 - Initial
Domain 6: E-waste management - Relates to the management (re-use, recycling, and disposal) of electronic waste (end-of-life IT equipment)			
E-waste reuse	6.1	Does your company reuse or refurbish IT equipment and other assets?	1 - Initial
E-waste recycle	6.2	Does your company dispose of ICT and other assets in an environmentally friendly way by recycling materials and components?	1 - Initial
E-waste disposal	6.3	Does your company dispose of ICT and other assets by not dumping it in the garbage?	1 - Initial
Green House Gas emissions management	6.4	Does your company manage green house gas emissions of its ICT assets and business processes?	1 - Initial
		Does your company consider not creating harmful emissions and waste?	1 - Initial
Radiation emissions management	6.5	Does your company manage radiation emissions of its ICT assets?	1 - Initial
		Does your company consider not creating harmful emissions and waste?	1 - Initial